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I. OUR COAL SUPPLIES AND OUR PROSPERITY.

With a "Coal Map" of the World.

In the year 1862, Mr. Edward Hull, of the Geological Survey, published a small compact work on the coal-fields of Great Britain, in which he incidentally discussed the question "How long will our Coal-fields last?" and replied by expressing his belief that they would last upwards of 1,000 years, at the then rate of production. In 1863, Sir Wm. Armstrong, the President of the British Association, in his address at Newcastle, took up the inquiry in what was at that time considered rather a sensational spirit, and declared the probable limit of the coal-fields to be about two centuries.

In 1865, Mr. W. S. Jevons, M.A., published a work on the "Coal Question," with "an inquiry concerning the progress of the nation, and the probable exhaustion of our coal supply;" in which he said, "If our consumption of coal continue to multiply for 110 years at the same rate as hitherto, the total amount of coal consumed in the interval will be one hundred thousand millions of tons;" and as Mr. Hull, whose figures he adopted, only estimated the whole available resources of the country at about eighty thousand millions of tons, there is, according to Mr. Jevons's view, a fair prospect of our supply being entirely stopped within a century.

When the startling work of Mr. Jevons was given to the world, the sensation created by Sir Wm. Armstrong's remarks at Newcastle had somewhat subsided, and the book was neglected until Mr. J. S. Mill, the political economist, took up the subject of the reduction of the national liabilities in the House of Commons last spring. He did not exactly say that he agreed with Mr. Jevons's calculations, but he gave them sufficient weight to justify their employment for the end he had in view, and his argument may thus be briefly stated: "We are fast consuming the stock-in-trade of our posterity; do not let us bequeath them our debts."

The Chancellor of the Exchequer (Mr. Gladstone) found this a

convenient lever to enable him to introduce a measure having the object proposed; for whilst the less scientifically-informed members of the Lower House were compelled to look on with astonishment, and dared not open their lips in the presence of so inexorable a schoolmaster as Mr. Gladstone, the initiated smiled, and allowed the effort to be made to diminish the national indebtedness—a very wise course on the part of both sections of the House.

It is right, however, that we should, *en passant*, remind our readers that not alone is the credit of having awed the House of Commons due to Mr. Jevons, but that they will find in the penultimate chapter of his work the suggestion thrown out that the effect of the rapidly decreasing coal-supply should be counteracted by the reduction of the National Debt.

No sooner, however, was the financial measure brought in, than other gentlemen in the House of Commons, practically acquainted with the question, called upon the late Government to appoint a Commission of Inquiry; and shortly after the subject was introduced by Mr. Mill, such a Commission was nominated, which is at present prosecuting its labours.

It is, of course, well known to our readers that the change of ministry brought also a changed financial policy. Mr. Disraeli withdrew the measure which was intended as the commencement of a new account in our national ledger, and all we have left now is the cry of dwindling coal resources and a Royal Commission of Inquiry.

No doubt these gentlemen will in due time present a Report to Her Majesty, which will be full of valuable information and suggestions; but as we apprehend that all the data for arriving at a sound conclusion (or as we shall presently seek to show, for *not* being able to arrive at a positive conclusion,) are as ripe now as they will be when a Report is issued, we shall venture to lay before our readers the best information at our command, and such views as we trust will at least have the effect of calming apprehensions that might otherwise be kept alive until the Report of the Commission is presented and published.

And let us first state, with regard to Mr. Jevons's book, which has created such a hubbub, and in which, a long year after its publication, our legislators and critics have discovered so much profound wisdom, that it presents evidence of honest care and perseverance; contains a great number of valuable facts intermingled with conscientious but erroneous opinions; and that whilst many of the generalities uttered by the author are undoubted truths, which might have been deduced with equal if not greater justice from facts totally unconnected with "the Coal Question," it unfortunately attributes the decline which the author apprehends, as it temporarily props up the supremacy of our people, upon an unstable materialistic support which really has very little to do

with the permanent foundations of our imperial grandeur and national prosperity.

We shall not merely content ourselves with thus passing judgment on the book; in the course of our inquiry some of Mr. Jevons's thoughts will serve as our points of departure, although it will appear that they lead us to conclusions totally at variance with those of the author. This book may be reviewed in the identical terms which he, curiously enough, applies to the opinions of one of the earliest writers on the subject of which he treats, *viz.* "The Reputed Quantity of Coal of Britain." "His remarks are highly intelligent, and prove him to be one of the first to appreciate the value of coal, and to foresee the consequences which must" (we should rather say "might") "some time result from its failure. This event he rather prematurely apprehended." . . . "Still his views on this subject may be read with profit even at the present day."

We propose to conduct our inquiry as follows:

First. We shall inquire: What are the present sources of our coal supply in Britain?

Secondly. Are those sources likely to extend? May we, in the course of time, have greater facilities for obtaining coal in Britain than we at present possess?

Thirdly. Are there any means by which such additional supplies should now be sought or encouraged?

Fourthly. How is our present supply consumed?

Fifthly. What general changes are likely to occur in the application of our coal resources?

Sixthly. From the foregoing, we shall endeavour to arrive at some conclusion as to the probable future of Great Britain, as it is likely to be affected by changes in our manufacturing industry, consequent upon a modification of our coal supply.

In all these inquiries our words must necessarily be few, and as we have derived our information from the best sources, we must leave it to our readers to employ the best means at their disposal for the rectification of our errors, if they should have difficulty in accepting any of our statements.

First, then,—"What are the present sources of the coal supply in England and Wales?"

From 17 coal-fields (of which 3, Anglesea, the Forest of Wyre, and Shrewsbury, are inconsiderable), which may be arranged under three groups: 1, The Eastern; 2, Western; and 3, Southern.* The coal-fields of Scotland, 6 in number, form another group, the Northern. The yield from the whole of these coal-fields was 98,150,587 tons in 1865.† If we take the estimate of Mr.

* See 'Quarterly Journal of Science,' No. 1.

† Mineral Statistics. R. Hunt, F.R.S.

McCulloch of the yield in 1840 at 30,000,000 tons, the total increase in 25 years will have been about 68,000,000, or at the rate of 2·6 millions per annum, which was nearly the amount assumed by Sir W. Armstrong (2,750,000 tons per annum).

There is no probability of absolutely new sources of supply beyond these coal-fields and their marginal tracts of Permian and New Red Sandstone. The geological evidence is against the supposition of the existence of coal under the Eastern and Southern counties of England, with the possible exception of a narrow trough under the cretaceous rocks of the Thames valley. This is owing to the uprising of the Silurian rocks beneath the newer formations of which we have indications in Leicestershire, Warwickshire, South Staffordshire, and Shropshire. It is also certain that the Somersetshire coal-field terminates to the eastward under the lias, and is disconnected with any possible coal-strata under the Thames valley.

There are several coal-fields of which it may be confidently affirmed that they have passed their prime, and are verging on decay; of these the coal-fields of Coal-brook Dale, in Shropshire, the Flintshire, and the South Staffordshire are the examples. There are others which have nearly attained their meridian of development, such as Durham, Lancashire, Warwick; Yorkshire, Derbyshire, and Notts (all one); and there are others which are capable of considerable increase in the amount of their yield; of which the examples are Denbighshire, North Staffordshire, Leicestershire (especially under the adjoining New Red Sandstone areas), Forest of Dean, and South Wales. Some districts of the Scottish coal-fields have also seen their best days, but on the whole the resources of the coal area of Scotland are on the same parallel as those of England and Wales.*

The following is a summary of the outputs of the coal-fields from the mineral statistics of Great Britain for 1865.†

		Tons.	Condition.
1.	Durham and Northumberland	25,032,694	(increasing)
2.	Cumberland	1,431,037	(increasing)
3.	Yorkshire, Derbyshire, and Notts	15,046,350	(increasing)
4.	Leicestershire	965,500	(increasing)
5.	Warwickshire	859,000	(increasing)
6.	Staffordshire and Worcestershire	12,200,989	(increasing)
7.	Lancashire } one coal-field	11,962,000	(increasing)
8.	Cheshire } one coal-field	850,000	(increasing)

* An interesting inquiry into the actual quantity of gas-coal, or cannel, in the United Kingdom, has just been concluded by Mr. R. Hunt, F.R.S., and is addressed to Messrs. Baxter, Rose, Norton, and Co., of Westminster. From this it appears that the total quantity of this valuable mineral is very limited; that the present supply of 1,418,176 (1865) might be increased to 3,172,000, which would go far towards exhausting the mineral in a period considerably less than half-a-century.

† Mineral Statistics. R. Hunt, 1865.

		Tons.	Condition.
9.	Shropshire	1,135,000	(declining)
10.	Gloucestershire, Somersetshire, and Devonshire	1,875,000	(ditto)
11.	South Wales coal-field (including Monmouthshire)	12,036,507	(increasing)
12.	North Wales	1,983,000	(increasing)
13.	Scotland	12,650,000	(increasing)
14.	Ireland	123,500	(declining)

The total output was 98,150,587 tons from 3,256 collieries; but the present progressive or retrogressive state of any of the above coal-fields is not always a criterion of their resources.

We now enter upon our second inquiry:

Are our sources likely to extend, or may we in the course of time have greater facilities for obtaining coal in Great Britain, or from other countries, than we at present possess?

It is hardly necessary to remind our readers that upon the replies to this inquiry mainly depend the estimate of the probable duration of our coal-fields. Let us therefore ask, first: Will improved systems of mining and ventilation enable us to procure coal below 4,000 feet, calculated by Mr. Hull to be the extreme depth? The answer involves many important considerations.

It may probably be admitted that high temperature can never prove a serious impediment to deep mining. Mr. Vivian has, we think, disposed of this question;* as it is one which may fairly be left to the progress of invention to solve. As Mr. Vivian remarks, "If heat were produced by additional barometrical pressure, it was equally true that by rarefaction we produced cold;" and he states that the process of rarefaction by machinery is now employed in the deep mines of France and Belgium. Although there is therefore no reason for supposing that the calculation of Mr. Hull of the combined temperature of the strata and air (120° F.), at a depth of 4,000 feet is incorrect, yet it is one of those objections to deep coal-mining which may safely be dismissed. This we believe to be Mr. Hull's present opinion.

A more formidable obstacle is likely to be found in the pressure of the superincumbent strata. And this may be experienced, not so much in the greater density of the coal, as in the difficulty of supporting the roof and sides of the air-passages, and the "goafs," or chambers from which the coal has been extracted. Already, with our comparatively shallow mines, this is often a difficulty; and how much greater is it likely to become, when instead of dealing with a pressure from 2,000 feet of strata, the depth is doubled. It is generally supposed that when the coal is removed the overlying strata form a natural arch which at first supports

* His 'Speech.' Ridgway, 1866.

the roof. This may be, when the strata are unbroken by faults or fissures over wide areas; an exceptional state of things. In such a case Mr. Vivian's analogy of "the small hole in the wall"* holds good, but if the cohesion of the beds is destroyed by ruptures (a very common occurrence in the form of joints and faults), we may expect the weight of the strata to exert an irresistible effect. We have been strongly impressed with the force of this reasoning, by a case which occurred in Dukinfield colliery, as stated by the manager about two years since. In the workings of the coal, 4½ feet in thickness, at a depth of 2,500 feet from the surface, the pressure was found powerful enough to crush in circular arches of brick-work, four feet in thickness; and in one instance a pillar of cast-iron, 12 inches square, 4½ feet in height, and supporting a roof of only 7 feet square, was snapt in twain.

Notwithstanding these considerations, we cannot but feel that in questions of this kind experience is likely to be the only safe guide, and we think this is one of the points on which the Royal Commissioners ought to ascertain the experience of the colliery managers and viewers of the deeper mines throughout the kingdom. Admitting, for the moment, the possibility that neither temperature nor pressure is likely to be found an insuperable obstacle even at the depth of 4,000 feet, we may confidently assume that only coal-seams of superior quality and thickness, capable of being mined economically, will be followed to this or any greater depth. The question of outlay of capital and additional cost per ton due to increase of depth, becomes formidable, and as Mr. Jevons has shown, this will be the last court of appeal in all questions of mining. To open out a colliery at the present day to a depth of 600 or 700 yards, cannot be accomplished under an outlay of 100,000*l.*, which sum has to be recouped in a term of twenty-five years or so, and to bear interest at the rate of 10 per cent. in order to form a successful speculation, and this can only be done where the seam is of good quality, proper thickness, and comparatively free from accidental irregularities, such as rock-faults, dykes, and "horse-backs."

When therefore the outlay comes to be nearly a quarter of a million, as it assuredly will be when the depth is 1,000 yards and upwards, instead of 600 or 700, we may feel sure that only seams of superior excellence will justify such an outlay. It is therefore inconvenient to adopt any sharply-defined limit of depth, as we may easily conceive the case of a seam of coal of such value, that it might be followed even to a greater depth than 4,000, while we may safely conclude that there are very few seams in any coal-field which will eventually justify such an effort. Still, admitting this,

* "The fact was, that you might make a small hole in a wall and yet not cause the wall to tumble down."—His 'Speech.' Ridgway.

we cannot grant all that Mr. Vivian demands in his estimate of the resources of the great South Wales coal-field. Not one of Mr. Vivian's mines in South Wales has reached one-half the depth of which he makes so small an account, and yet he must have a tolerable experience of the difficulties and outlay of mining by machinery even to the moderate depth of 400 or 500 yards. If it were taken for granted that because the coal is *there* it must be accessible, the Royal Commission would not be needed.

Let us now ask: Are we likely to procure a supply from below the sea, or estuaries of Great Britain?

The districts in which coal-measures extend under the sea are certainly few, considering the large areas the coal-fields occupy in the land. We cannot expect any great addition to our supply from these tracts, as it is evident the entrance to the mines must be always above the limit of high tides. In Cumberland, Flintshire, and a few other places, coal has been worked under the sea with success for many years—one of the mines at Whitehaven extending 3,200 yards from the shore. In Scotland the coal formation constitutes the sea-board of parts of Ayrshire, Fifeshire, and the Lothians. In England we may expect a very large quantity of coal to be recovered under the sea between the north of the Tyne and the Tees, provided great care be taken to leave barriers for stopping off the waters for some distance from the outcrop of the seams downwards. We may also expect at some future time, coal to be wrought under the estuary of the Dee, and possibly that of the Mersey, and again along the coast of the Vale of Clwyd near Rhyl. But the most important tract is that which is covered by the waters of Swansea and Carmarthen Bays. In the latter case many hundreds of acres of the lower and most important seams are under water, and we shall not be surprised if, at some future time, steps be taken to reclaim from the ocean by embankments a sufficient extent of the estuary to allow of the recovery of the whole of the coal.

To this inquiry let us add the parallel one: In what districts and under what formations *may* there be coal still undiscovered?

It is perfectly true, as stated by Mr. Vivian, that some of our coal-fields are merely outcropping portions of larger concealed coal-fields. If we take the Lancashire and Cheshire coal-field on the North, the Flintshire, Denbighshire, and Shropshire coal-fields on the West, the North Staffordshire coal-field on the East, and the South Staffordshire coal-field on the South, we inclose an enormous area under nearly the whole of which we may safely state that coal exists within a depth of 5,000 feet of the surface.* If we were to adopt a limit of 4,000 feet, the area would be considerably reduced,

* See Map of the Coal-bearing Tracts of Great Britain, 'Quarterly Journal of Science,' No. 1. Also, Hull's 'Coal-fields of Great Britain.' Second edit.

especially in Mid-Cheshire; but within this latter depth there are large areas in Leicestershire, Warwickshire, Staffordshire, Notts, and probably the eastern districts of Yorkshire, along a band of country ranging from the estuary of the Tees southward by York, and crossing the Humber near Goole. This tract is overspread by Liassic and Oolitic formations, containing the ironstone of the Cleveland Hills; and if Mr. Vivian's somewhat sanguine views as regards depth be adopted, it would be quite possible to conceive of a shaft entering the ground at the outcrop of the Liassic ironstone, and penetrating to the underlying coal; the depth, however, would be considerably greater than 1,000 yards over the whole district.

Into the overlying Permian and Triassic formations, collieries have already advanced to a considerable extent. The Magnesian Limestone of Durham, Yorkshire, and Notts has been and is being pierced by many shafts, while the water which saturates this and the underlying Permian Sandstone, and which at first was a formidable impediment, is pumped for the supply of the towns. The New Red Sandstone along the southern margin of the Lancashire coal-field, as also that near Rugeley, Cannock Chase, and Ashby-de-la-Zouch have been pierced, and the underlying minerals won; while in Somersetshire, owing to the thinness of the Triassic rocks, the Lias itself has been pierced by several collieries. Thus has been commenced a phase of coal-mining under the overlying geological formations, destined at no distant day to assume much larger proportions.

While maintaining that there are very large areas—larger in fact than the areas of the English and Welsh coal-fields themselves—which contain coal overlaid by Permian, Triassic, and Liassic formations, we at the same time hold that this area has been overestimated both by Mr. Vivian and those who have given an opinion on the subject. We concur with Mr. Jukes* in his view that the coal-measures were never deposited in that part of Worcestershire south of the Clent and Licky Hills; and Mr. Hull has shown that, both from the thinning away of the coal-measures towards the south-east, and from the uprising of the Old Silurian rocks during the coal period, we are not to look for coal under the eastern counties of England. The discovery of slate rock at a depth of 1,035 feet at Harwich, beneath the Cretaceous formations, is significant evidence of the credibility of these conclusions.

The foregoing considerations lead us to pause for a moment in our inquiry, and to ask our readers whether, provided these views be correct, all calculations as to the probable duration of our coal supply are not at once invalidated by the fact that it is at present beyond the power of any living person to estimate what that supply

* 'The Geology of the South Staffordshire Coal-field.' Mem. Geol. Survey. Second edit.

is likely to be. The depth to which mining may be carried (*for the coal is there*), the probable stores beneath the sea, under our rivers and estuaries, and the extension of the present fields, are, we maintain, questions at present so vaguely defined and so incapable of a satisfactory solution, that it matters little in what ratio the consumption is likely to increase. Before a man is in a position to decide how long a newly-acquired fortune is likely to last, he should at least be certain of its amount, or his estimate of its probable duration is worthless.

Proceeding practically in our inquiry, we shall for the present dismiss from our consideration all means of obtaining fresh data for arriving at an estimate of our future resources, except that of "boring" for coal in suspected new fields.

On principle, we are by no means favourable to the grant of public money for the prosecution of borings in search of coal: first, because the benefit or damage, as the case might be, could only accrue to private individuals on whose property the experiments would be carried out; secondly, because we are not at present, nor shall we be for a long time to come, in such need of additional coal-ground as to necessitate experiments of this kind; and chiefly, because we believe that when the time does arrive that such experiments are needed, *they will be carried out by private enterprise, which in this country generally manages matters of this kind better than the Government.* At the same time, as the subject has been pressed on the attention of the Royal Commissioners, and they may possibly come to the resolution to recommend Parliament to make several experiments with the public money, we now suggest the following localities for boring; the actual sites in each case would of course require mature consideration.

Cumberland—St. Bees.

Cheshire—1. The valley of the Dee, near the City of Chester. 2. The promontory of Wirral, about two miles south of Birkenhead, on the banks of the Mersey. 3. Also some point near Hoylake, at the mouth of the Dee.

Lancashire—A spot to be selected between Liverpool and Runcorn Gap, along the estuary of the Mersey.

Salop—1. Market Drayton. 2. Shiffnal.

Staffordshire—1. The valley of the Trent, along the northern border of Cannock Chase, near Colwich. 2. New Red Sandstone east of Stafford.

Warwickshire—In the centre of the plain of Permian beds, west of the Warwickshire coal-field.

Thames Valley—1. Reading. 2. Kentish Town; the boring already commenced to be continued.

The Weald—Tunbridge Wells.

Thus then the first three divisions of our inquiry lead us to

the conclusion that whilst it is as clearly impossible for any one in the present day to estimate, even approximately, the future sources of our coal supply as it would be to compute the quantity of fish in the sea, still we have every reason to hope that, provided our consumption increases in a moderate ratio, the stores at our disposal are not likely to be exhausted even as soon as the more sanguine of our statisticians have calculated.

And now we enter upon the fourth inquiry, to form some idea as to our future *Consumption* of Coal; and here we must remark that Mr. Jevons's want of business knowledge has led him into statements which such gentlemen as Mr. Gladstone, or Mr. Mill would not be able to question, but which, as we shall show, will not bear discussion either on the basis of past experience, or of our commercial prospects.

We must begin by asking: How is our present supply consumed? No one can give more than an approximate answer to this question. The labours of the Royal Commission will doubtless throw fresh light upon it; for with such an untiring caterer as Mr. Robert Hunt, the Keeper of the Mining Records, they cannot fail to accumulate much valuable information. But for the purposes of our inquiry, and with sufficient accuracy to lend confidence to our conclusions, we may safely employ the following approximate figures:*—

	Tons.
The total quantity of coal raised in Great Britain in 1865 was about	98,000,000
Of this there were exported about	9,200,000
Leaving for home consumption	88,800,000
Say about . .	89,000,000

It is estimated that for domestic purposes each inhabitant consumes a ton of coal, and the population of Great Britain may be taken in round numbers at twenty-four millions:—

	Tons.
For domestic consumption, therefore, we may estimate	24,000,000
For all purposes of pig-iron manufacture, that is to say, for making the pig; engines, &c. about	15,000,000
For all purposes of converting iron . . „	15,000,000
For gas-making . . . . . „	10,500,000
For textile fabrics . . . . . „	3,000,000
For all other purposes . . . . . „	21,500,000
Total „	89,000,000

Now let us consider these items separately; and deferring for the present the question of our coal exports, as they are intimately

* Of course these approximate figures are the result of careful inquiries.

associated with our naval consumption, we will take the subject of our domestic needs. It is estimated, as already remarked, that one ton per head of the population is the quantity so employed, and therefore it may with confidence be said that between one-third and one-fourth of our whole coal supply is burned on the domestic hearth.

In the course of his long argument, in which whole chapters are devoted to matters of secondary importance, we find only one mention of our domestic consumption of coal in Mr. Jevons's book, and the perusal of the few words on the subject (p. 103) really leaves us greatly perplexed as to the cause of his reticence. He says that "if our population could be induced to abstain from the enjoyment of a good fire, the saving effected would not extend over more than about one-third of the total consumption of coal, the domestic consumption being on an average about one ton per annum per head of the population." This may be a trifle not worthy of the consideration of a philosopher who deals in abstract questions of immense magnitude, but it is of sufficient moment to command our attention.

The increase in the domestic consumption of coal is almost sure to keep pace with increasing population, unless some substitute is found for the present uncleanly and not very healthy* method of warming our houses and cooking our food, and it would seem at present that no item in our consumption is likely to be more regular than that one.

It will be convenient first, to look at Mr. Jevons's estimate of what would be our consumption "assuming the present rate of growth, 3½ per cent. per annum, to hold" for a century from the present time. In that case, he says, our total consumption of coal in the year 1961 would be 2,607,500,000 tons. Retaining the same proportion for domestic uses, there would be applied to such purposes between 700 and 800 millions tons of coal, and Great Britain would possess a population represented by the same numbers, 700 to 800 millions of inhabitants! We leave it to our readers who have perused Mr. Jevons's work to decide whether we are not justified in this application of his logic and statistics; in fact, such an inference appears inseparable from his argument.

In his speech on moving for a Royal Commission,† Mr. Vivian reduced another of Mr. Jevons's geometrical calculations to an absurdity, by a somewhat similar process. "If the increased consumption of coal is to be calculated by geometric progression, I have an equal right to calculate the increased production of iron in the same manner, and therefore at the rate of 5⅓ per cent. per annum. But I will be merciful and take it at 5 per cent.; then 4,769,951 tons of pig-iron, increasing at the rate of 5 per cent.

* We refer to its effect out of doors.

† 'Speech on the Coal Question.' Ridgway, 1866.

per annum, will in 100 years be equal to 626,991,583 tons per annum, and 1,125,986,597 per annum in 112 years, and the coal to be used in making this iron, at the same rate for pig and wrought, would, according to this theory of geometric progression, be stated thus:—24,435,747 at 5 per cent. per annum = 3,213,331,617 per annum in 100 years, and 5,770,680,864 in 112 years. In 1961 iron would use 2,775,796,665 tons of coal. But how does this correspond with the quantity Mr. Jevons has calculated upon? He states, from statistical calculations, that the total production of our coal-mines in England must in the year 1961 amount to 2,607 millions of tons per annum to meet all the wants of England, including of course the manufacture of iron. So that we have here a very curious paradox reposing upon the incontrovertible logic of figures, *viz.* that the lesser quantity, although contained in it, still overtakes the greater, and we arrive at this ridiculous result, that the quantity of coal consumed for the making of iron alone exceeds the total quantity which Mr. Jevons lays down, according to the theory of geometrical progression, as required for the total consumption of the kingdom, including iron, 100 years hence."

We do not wish our readers to suppose that Mr. Jevons positively asserts his belief that the consumption will be so great a century hence, but he startles us with such sentences as the following (already quoted) in italics:—"*If our consumption continue to multiply for* 110 *years at the same rate as hitherto, the total amount of coal consumed in the interval will be* 100,000 *millions of tons.*" And we maintain, looking at the context, that it would have been just as sensible (or otherwise) if he had said that, should the demand for coal be further stimulated by our increasing prosperity, we *might* not have a pound of coal left in England twenty years hence! He devotes a whole chapter to the subject of the growth of our population, and we cannot find that he anywhere compares it even with any hypothetical increase in the demand for coal.

We do not pretend to express an original opinion as to the probable ratio in which our domestic demand is likely to increase. It would be absurd to do so. Already many of our cooking-ranges and stoves are heated with coal-gas. Fifty years hence they may all be heated with American or British petroleum gas, or any one of a score of old or new heat-producers; and persons who deride the idea of coal substitutes (Mr. Jevons amongst the number), have no eyes for what is passing around them. Of this, more hereafter. All we can say is that, at present, calculating the domestic consumption at one ton per head of the population, we consume about 25,000,000 tons annually; and should the population of Great Britain be doubled or trebled during the next century, the steadiest item, comprehending one-third of our whole consumption, may rise from 25 to

50 or 75 millions of tons. We, however, anticipate no such increase.

Let us now pass to the second and third items of consumption (embracing also about one-third of the whole), *viz.* coal used in the production and conversion of iron.

Mr. Bernhard Samuelson, M.P., a large ironmaster and machine-maker, expressed the view, when the coal question was first debated in the House, that if coal became very much dearer here, the export of iron from this country to many places would cease, and that the United States would beat England in neutral markets; but he might have gone still further, and might have said, with perfect truth, that not only the export trade in pig-iron, but also in some of the manufactures of iron would probably leave us. A question of equal, some think of greater importance with that of the coal supply in the production of an article of such low value as iron, is that of labour; and although there may be periods when that is high abroad, as a rule, it is greatly in favour of the continental manufacturer.

Let us mention a fact or two worthy of consideration.

Whilst coal is actually so cheap as to serve as ballast for steam-vessels to America, and in some cases to be brought back again to England (as we shall explain hereafter), locomotive engines have been made abroad (we believe by a firm in Creusot) for one of our English railways; others, by a house at Carlsruhe for Indian railways; and a large firm of English ironmasters and coal-proprietors have lately ordered a pumping-engine in Belgium for one of their Northumbrian collieries. Furthermore, the cost of iron ships has latterly, owing to increased wages both in manufacturing iron and building the vessels, approximated so closely to the cost of iron ships built in France, that very little more would turn the scale in favour of the foreign maker.

But what do these facts indicate? Certainly not that the demand upon our coal resources will increase, but rather that it will be *pro tanto* relieved, and that without a failure of our coal supplies, our industry and enterprise must be turned into new channels.

Closely connected with this part of the subject, as Mr. Samuelson showed, is that of our manufactures and exports of textile fabrics. Whilst in 1865 about 30,000,000 tons of coal were consumed in the production of a class of articles, of which we sold to foreign nations in all 9 millions worth, only 3,000,000 tons were required for the manufacture of textile fabrics, of which our exports amounted in value to 96 millions of pounds sterling. This exhibits in a most striking manner how little our coal supply may have to do with our material prosperity in the future. That we may cease to be the producers of the coarse material—iron in its various forms—is not at all unlikely, but it by no means follows that we should at

once become small-ware manufacturers, that "our work," to quote Mr. Jevons, "will be that of the trinket and the watch rather than that of the herculanean engine, hand work rather than machine work." Such writers really forget that the world is in a progressive state; that there are such undertakings as telegraph cables; such trades as spinning, weaving, paper-making, printing, engraving, photography, and hundreds of old or of nascent avocations, arising out of the wants of modern civilization, and requiring not only the hand of the skilful artificer but the brain of the experienced mechanician in the machinery needed for their prosecution.

Turning now to another item in our coal consumption, that used in the gas manufacture, we find that one-eighth of our whole supply is employed to give light to our streets and houses; and to read the comments of some writers on this subject, one would imagine that it was a decree of Providence, that whilst every day new sources of illumination are discovered, vying with each other, and even with the sun himself in brilliancy, we should be condemned for ever to live in the pale, sickly, partial light emitted by a foul-smelling, explosive gas; noxious and dangerous in its manufacture, and extremely troublesome in its application. What has mankind done to merit such a sentence at the hands of our coal alarmists?

It is easy to sneer at persons who believe that substitutes will be found for coal—in this case for coal-gas—and to call them chimerical and visionary; but was not the same language held when people burned tallow and wax candles? Is it not always repeated when some old custom is about to disappear? From what source do we already obtain our most brilliant light? Our best lighthouses, few in number, are or are about to be lighted by magneto-electricity, and Mr. Wilde's recent invention, described at length in another portion of this Number,* bids fair to take the electric spark into our houses, streets, and workshops.

One of our ablest and most experienced electricians writes us as follows:—"My conclusions *were* that electricity could not be used at less than a hundred times the cost of coal. If Mr. Wilde proves his position, this view must be materially modified. The value of his machine for producing light, heat, or mechanical power, can only be determined by knowing the cost of the power by which it is driven."

The last-named inquiry will be answered presently.

But we need not even have recourse to electricity as a substitute for gas, although we repeat the conviction that before long that and other bright illuminating sources, as magnesium, will take the place of gas, oil, and tallow. Petroleum itself, the supply of which

* Where the past and future of magneto-electricity are fully treated.

appears at present to be unlimited, and to present new sources year by year, will become a most important agent both for lighting and as a motive power. "But," says Mr. Jevons, "*what is petroleum but the essence of coal,* distilled from it by terrestrial or artificial heat?"*

Here, again, the clever author of the work which has excited so much uneasiness is significantly brief, and what little he does say is hardly correct. Neither he nor any one else is justified in affirming that "its natural supply is far more limited and uncertain than coal," for it is only just discovered, and the supply in America and elsewhere appears to be almost unlimited. As to its artificial production, he says it can only be had by the distillation of "some kind of coal;" but what kind of coal is used for the purpose? Could the shale from which it is at present extracted at home be employed for any other purpose? and how much is so produced? These are questions which Mr. Jevons should have considered.

Moreover, if he recollected that petroleum is the "essence of coal," and that it is so dear as 15*l.* per ton, why does he forget that the freight from America upon an article worth 15*l.* per ton, as compared with that upon 1*l.* (which will probably be the price of native coal at the American outports before many years), completely annihilates the carrying distance between the two continents? And should petroleum come into use for engines, as well as for lighting (which recent experiments here and in the States render more than probable), the great difficulty in the way of the importation of our fuel at once disappears, and we shall have good cause to rejoice in the fact that an important source of our light and heat will be the same as that of our food, and that we shall be less dependent upon the resources of our little island. To show our readers that we are not merely theorizing, and that it is only a question of mechanical application, and consequently of the exercise of the inventive faculty, which will place other easily-obtainable substances above coal or coal-gas as illuminating and force-giving agencies, we will just transfer to our pages two or three facts from the recent address of Dr. Letheby to the British Association of Gas Managers.† First, as to heating power:—

Whilst Cannel gas raises	1,950 lbs.	water 1° Fah.
Common gas will raise	2,786 lbs.	„
Paraffin (petroleum) will raise	3,619 lbs.	„
Tallow will raise	5,054 lbs.	„

Now, as regards lighting power:

When a magnesium wire the 100th part of an inch in diameter is doubled and twisted, it burns at the rate of 2·4 grains per minute, and gives the light of about 69 standard sperm candles;

* 'Coal Question,' p. 141.

† 'Chemical News,' June 15, June 22, July 6, 1866.

"an ounce of the wire is therefore equal in light-giving power to 3½ lbs. of sperm candles." The Drummond light (oxyhydrogen) we will pass over; its power varies from 19 to 153 candles, according to the gas in which it is burned—*coal-gas being the lowest;* and as to the power of the electric light, it "varies from 650 candles to 1,444, the average being about 1,000!"

This is Dr. Letheby's opinion; but according to the view of Mr. Crookes (who, in his article on the subject, enters more fully into details), the lighting power is immeasurably greater; and when he first entered into a calculation of the cost of working Mr. Wilde's machine, he estimated roughly that it would require 11½ lbs. of coal to produce with it a light of 4,000 candles for one hour!

The whole inquiry is still an open one, and is practically in its infancy. If we were asked to decide whether or not we should continue during the next ten or twenty years to employ coal as the direct source of our light, we should certainly answer affirmatively; but taking vested interests, gas-pipes, fittings, and all that sort of thing into consideration, we should not be disposed to give coal-gas a lease of more than twenty or thirty years. In fact, with our present information and experience, we may pronounce it the very height of absurdity to assert that, a few more years having passed over our heads, the employment of coal-gas for illuminating purposes may not begin to wane, and it would be equally foolish to deny that it may entirely cease to be used within the next fifty or one hundred years.

We cannot, however, close our eyes to the fact that an enhancement in the price of coal, to which we are liable at any time, even from the cry of coal exhaustion, might cause us serious temporary inconvenience, and this more particularly in the matter of ballasting our vessels. But even here the facts have been misconstrued, and the matter has been considered in only one of its aspects.

At present we have not only an export of about 9,000,000 tons, which gives employment to our shipping, and serves abroad as current coin in payment of imports, but a large quantity of coal is taken out by our steamers to be burned on the passage home. Should the price of coal rise at home, it would, as matters stand at present, rise also abroad, and would stimulate the production of coal out of England; thereby not only injuring our barter trade, but compelling us to have recourse to other substances of a less "paying" kind for ballast.

This is the unfavourable view of the question; but it has also a favourable aspect, and this we can best exhibit by following Mr. Jevons in another of his erroneous arguments.

More than once he draws attention to the fact* that sailing ships are gradually disappearing from the ocean, and that steamers

* 'The Coal Question,' pp. 98 and 250.

are taking their place; so that 50 years hence the former will be the canal boats of the deep, and he couples this with the circumstance that many of our steamers carry sufficient coal on the outward voyage to serve them on the homeward one also; or that cheap English coal is sent at a low rate to foreign ports to supply our sea-going steamers.

But why did the author, whilst he was looking forward 50 years, regard only so much of the probable future of our trade as would lead to the inference that our export demand might increase?

In America, India, Polynesia, Australia, the coal production is being vigorously pushed forward, and the real inquiry is as follows:

First, is it advantageous to the British steam-owner that he should, for the homeward voyages of his steamers, have to send out his coal to distant ports, or to carry it to the exclusion of better-paying freight? and secondly: Will the present state of things long continue?

The first question a child may answer. Excepting in so far as we have already shown, as a matter of profitable barter, it is by no means to the advantage of the nation nor of shipowners that they should have to carry coal; and as for the second inquiry, there is not the remotest doubt that before many years are over we shall have cheaper supplies of indigenous coal for our sea-going steamers at the foreign ports than any that *we* can provide, even at our present rates of freight. People who write and speak on such grave matters should not be content to heap together a mass of hypothetical statistics, they should descend to the investigation of actual *facts* as well, and their conclusions would be materially modified.

One of our largest steam-ship companies, trading with several American and European ports, consumes annually about 300,000 tons of coal; a large proportion of this is employed in their trans-atlantic steamers, and the necessity for ballast sometimes compels them to carry coal out to America, bring it back, and even to discharge a portion in England; this is, of course, done at a serious loss. But there are times when they are not so pressed for freight, and when the reverse is the case, or the English coal is rather higher than usual; they then purchase indigenous coal at New York or even Halifax, and they estimate roughly that *already* from 10 to 50 thousand tons of such coal, according to circumstances, finds its way annually into consumption with them. What will it be when the immense coal resources of America are developed? and when, on a larger scale, that continent shall have passed through what was our "wood age?"

In a lesser degree the same thing already holds good in the east. Borneo abounds in coal; the resources of our Indian and Australian colonies are fast developing themselves, and it will be as ridiculous to talk of sending coals there, 50 years hence, as it is now to speak of sending them to Newcastle.

This portion of the subject, too, is just beginning to be unfolded; but in order to enable our readers to form their own judgment as to whether our coal exports are likely to increase permanently, or whether they will not before long begin to fall off, and at last cease altogether, we have sketched out an outline map of the earth with its coal-bearing tracts, from which they will see what relation our coal-supply bears to that of the whole world.

From this map, which it must be remembered represents only, as it were, the nuclei of the future coal-fields of the world, it will be seen that as soon as those become developed, the fields of Great Britain will sink into comparative insignificance. At present England exports, say in round numbers, 9 millions of tons; in 1864, her exports were 7,529,341 tons.

Of these she sent 1,387,675 to France. This is certainly a large quantity, more than 1 per cent. of our whole supply, and our neighbours are likely to remain our best customers for a long time, although they are making great efforts to develope their own resources. Denmark and the Duchies took 522,683 tons, and there also our exports are likely to continue for some time. Sweden and Norway together took between 300 and 400 thousand tons, and the same remark applies to those countries. This accounts for rather over two millions of tons.

On the other hand, the exports to Spain and Portugal, Italy, the Mediterranean ports, Turkey, and North Africa, amounting also to more than 2 millions of tons, will soon be affected by the developing fields marked on our map as No. 9, Turkey; 10, Spain and Portugal; 14, Asiatic Turkey. The fields of Prussia, Silesia, and Poland (5, 7, 8) are also extensive, and will give increasing supplies to countries at present drawing upon Great Britain.

Russia takes about 400,000 tons, but possesses enormous fields (Nos. 11 and 12) partly explored, of which the extent cannot at present be computed.*

And now, if we turn to North America, which imported from us in 1864, 334,354 tons, the West Indies taking 529,361 tons, South America 415,203, together over 1,200,000 tons, we shall find that there is no reason why, in a few years hence, this export should be entirely stopped, the continent and islands referred to taking their supplies from the fields numbered respectively, 21, British possessions in America; 22, United States; 23, Vancouver's Island; 24, Brazil. Indeed, large quantities are already sent coast-

* The production of coal in Belgium in 1836 was about 3 millions, in 1865 about 9,700,000
" " France about 11,300,000
" " Russia in 1847 was about 3 millions, in 1865 about 6,300,000
" " The U.S. of America in 1860 was about 8,300,000, in 1865 about 14,590,000
—Hunt's 'Mineral Statistics,' 1865.

wise from the Pennsylvanian coal-fields to the West India Islands; and in addition to this, it is not improbable, as we have shown, that our ocean steamers will take a considerable portion of their supplies from these same fields, instead of carrying out an excess for the homeward voyage to England.

Looking to the East, we find that the East Indies alone took, in 1864, 603,614 tons, Australia only 13,127, and instead of being importing countries, there is little doubt that the coal-fields, No. 15, India; No. 18, Borneo; and Nos. 19 and 20, Australia and New Zealand, will not alone yield them ample supplies, but will also serve to coal the ocean steamers trading and likely to trade between Europe and those far distant regions.

We have analyzed the exports of 1864, which fell short of those of 1865 by about 1,700,000 tons, because the detailed exports of the latter year were unattainable, but our object has been to show in general terms that should the price of coal in England rise, and the numerous resources of distant countries become developed (indeed, without the first contingency), there will be a natural check upon our exports, and in time probably a *set towards* instead of from Great Britain.

There now remains for consideration one other item, or series of items which we have grouped together as a section of our coal supply, *viz.* that "for all other purposes." This embraces locomotives, factories of all kinds, and the general purposes of trade.

In some of these the consumption of coal is no doubt a material element; in none, however, is it a matter of such moment as to preclude the use of substitutes in case the price of coal should render that article unattainable. It is almost needless to refer further to petroleum; it is being successfully tried both for land and marine engines, and probably before the Royal Commission presents its Report, it will give evidences of being likely to effect a complete revolution in our heating processes.

But let the substance employed for driving our stationary and locomotive engines be what it may, it will be a matter for congratulation and not one for regret, if our manufacturing processes increase in a rapid ratio, and we shall be as well able, with improving trade, to pay a higher price for our fuel, as the labouring man, out of increased wages, is enabled to pay advancing prices for his provisions.

It has been impossible, in an article like the present, to enter with anything like detail into the consideration of this vast and complicated question; but we have endeavoured to show, in opposition to the views of those who are prematurely apprehensive of the exhaustion of our coal-supply:—

1. That it is at present utterly impossible for any one to define the boundary, either vertical or horizontal, of our coal strata, and therefore no estimates that can at present be offered are fit

data for calculation; but that it is highly probable our resources are far in excess of the views of our most sanguine geologists.

2. That, looking at the coal resources of other countries, our exports are not likely to prove a permanent drain upon our resources, and our ocean steamers will probably ere long obtain cheaper supplies for their homeward voyages than they at present draw from English collieries.

3. That any considerable increase in the cost of coal is likely to interfere materially in our iron trade, more especially the raw material;* and that it is not unlikely that we may not only have to submit to the loss of our export trade, but may even find it more economical to import various forms of iron, crude and manufactured, from foreign countries.

4. That there is no element of certainty in the continued increase in our consumption of coal for heating and lighting purposes, especially the latter; and that it is probable that the use of gas (which now takes about one-eighth of our whole supply) will, in time, be superseded by better lighting agents, just as *it* has to a large extent superseded candles.

5. That the most valuable staple manufactures of Great Britain absorb a comparatively insignificant portion of our whole coal resources, and it is to be hoped that any enhancement in the price of coal will be more than compensated by increasing material prosperity, enabling the manufacturer without inconvenience to pay such an extra cost of fuel. At any rate it is clear that a very great absolute increase may and probably will take place in our general home production and foreign barter trade in valuable manufactures, with hardly a perceptible effect upon our coal resources.

But whilst we thus join issue with the coal alarmists on these questions, we think it but due to them to admit that only good can result out of the inquiry which has sprung from the expression of their alarm. It is well, in the first place, that we should not depend too much upon one source of our mineral wealth for such a variety of purposes as we do at present. Before the outbreak of the American civil war, it would have appeared almost as absurd to cry out for new channels for obtaining a cotton supply, as it now does to express a fear of coal exhaustion, but we never know, when we have "too many eggs in one basket," what accident may overturn it. Again, it is not wise to trust too implicitly in any portion of our material wealth, because it has a tendency to make us apathetic; to cause us to "lie on our oars." And the agitation of the "Coal Question" has reminded us of our National Debt; it should remind us *how that debt was chiefly accumulated,*

* Within the last few months, however, one of our most experienced iron-masters has produced an improved quality of iron, with a consumption of anthracite coal reduced one-half. See "Chronicle of Mining," present Number.

and if we are unable at present to effect any material reduction in its amount, it may at least serve as a warning to our people, not to increase it by allowing themselves to be led into the quarrels of their neighbours!

We cannot agree with Mr. Jevons in the closing remarks of his volume (which we admire though we have submitted his views to sharp criticism), that "we have to make the momentous choice between brief greatness and longer mediocrity."

Great Britain may, if she please, remain *Great* Britain to the end. That her monarch will be the Emperor or Empress of India, and that she will send out governors to Australia for ever, we do not for a moment contend; but whether she shall be peopled with a happy and respected community for ages, long after her "coal supply" is really exhausted, depends not upon any single source of her material wealth, but upon the use which the nation makes of that wealth, and of the mental resources which have been so lavishly bestowed upon it by Providence.

Rome fell because she had become luxurious and effeminate, and wild, hardy hordes overran her possessions whilst her rulers, armies, and citizens revelled in luxury and licentiousness. *Spain was ruined through the mineral resources of her colonies*, and her "influx of gold" has become a bye-word to nations.

The life of a people is the reflex of that of an individual.

Great Britain harbours within herself all the elements of a long life, by the side of the most dangerous materials of corruption and premature decay, and it depends upon herself which shall predominate. Will her labouring population become more sober; or will they, with increasing means, indulge more freely in the enervating cup of intoxication? Will her middle classes allow their thoughts to be absorbed by trade, or by objects of petty ambition; or will they cultivate the arts, the sciences, literature, and true religion? Will her nobles cease to consider themselves differently constituted to their inferiors, and, neglecting their own education, endeavour to maintain their position in society by keeping down those below them; or will they avail themselves of their wealth, leisure, and opportunities to become the shining lights of the nation? These are questions in relation to our continued greatness, of far higher moment than our "coal resources," and it should be the aim of our people, not solely to accumulate wealth; not only to maintain the supremacy of our navy, or of our army, or to secure the possession of our colonies; but also to prepare by a temperate and peaceful manhood, by setting a good example to our more impetuous neighbours in the vigorous period of our national existence, to pave the way for a peaceable and respected old age, and for what few great nations, if any, have yet experienced, the "*decline*," without the "*fall*" of our empire.

II. THE PUBLIC HEALTH.

On the Sanitary Condition of Hull, Bristol, Glasgow, Leeds, Manchester; and on The Sanitary Act, 1866.

In resuming the consideration of the all-important subject of the present article, it will be convenient that we should refer cursorily to our remarks on the Mortality of Liverpool, published in the last number of this Journal.

We there showed that the high rate of mortality in that important seaport was the index to a sanitary, or we should rather say an insalubrious condition, highly favourable for the importation of Cholera into England; inasmuch as Liverpool is the chief station on the high road for emigrants and others likely to convey the infection from abroad into Great Britain.

Quoting the Report of the Local Medical Officer, we stated the causes of the high mortality to be zymotic diseases arising from overcrowding, drunkenness, and other forms of immorality which lead to poverty and destitution.

When we came to inquire into the means taken by the authorities for ameliorating the condition of the poor, we found these to be the most meagre and insignificant, for whilst very large sums had been expended to benefit the gentry and the wealthy tradespeople, miserable grants were doled out for the improvement of closed courts and untenantable houses, and the interests of the public were found to be sacrificed to those of private individuals, to the whims of local cliques, or to the exigencies of local politics.

These startling revelations carried us to the inevitable conclusion, that it would be necessary to appoint a special Committee of the House of Commons to deal with a matter of such grave national as well as local importance.

But whilst we penned these remarks, severe as they may have seemed to many of our readers, and just as they were acknowledged to be by the Liverpool journals, we were little aware of the sad and culpable neglect of which the local authorities, not only in Liverpool but in many of our other large towns, have for years past been guilty towards their defenceless poor; and when, to the reports of credible informants, we added a close personal inspection, we found a state of things so revolting that we rejoice not to have known it previously, for we should else have been tempted to print in these pages an account of facts, which at the present day would be deemed shameful, and which to posterity will appear incredible.

The anticipated Public Health Bill, to which we shall refer presently, and other causes have conduced to the amelioration of those conditions in Liverpool and Leeds, and it is our intention to refer to them only, so far as it may be necessary for awakening

shame in those towns which obstinately refuse to remove similar stains from their municipal escutcheons, and who persist in setting their poor denizens an example of slovenliness and filth.

Deplorable as it may appear, it is nevertheless true that the only efficacious agents in sanitary reform are terrible visitations of disease, or stern compulsory legislative enactments. Both those agents are at present in active operation amongst us. Cholera, of which, in common with our cotemporaries, we predicted an outbreak during the summer, is committing havoc among our people; and before the prorogation of Parliament the Conservative Ministry wisely sought the co-operation of the Liberal framers of the Public Health Bill, and with their aid pressed it rapidly through Committee, under a cross-fire of obstructives, whom we should hardly have expected to find amongst our enlightened legislators.

We have to thank Providence for a visitation of Cholera, and to pray that the nation may not only be patient in enduring it, but ready to profit by the infliction; and we have also to be grateful to one who has had the decision and wisdom to insist upon sanitary reformation in all our towns and villages, to the Right Honourable Henry Austin Bruce, who (assisted by the late Home and Irish Secretaries) introduced the Public Health Bill, and who, whilst in the cold shade of opposition, was patriotic enough to see that it should became law.

Of the salutary effect of a severe outbreak of disease upon the inhabitants of a neglected town, it would hardly be possible to find a more striking illustration than the first on our list, *Hull*.

In the year 1848–9 Hull was visited by Cholera of more intense severity than any town in England. Lying low, and bordered on one side by marsh-land, it added bad drainage and a defective water-supply to its natural disadvantages; but about the time of the visitation it possessed a mayor of peculiar ability and merit, who rendered such services to the town in the matter of sanitary improvements, that when Her Majesty visited Hull, she knighted Mr. now Sir Henry Cooper, and in conferring the honour she announced to him that she had done so at the express wish of the inhabitants for the services to which we have referred.

The death-rate of Hull in the year 1851, when the Improvement Act was passed, was 36, whilst in July, 1866, when that of London was 22, Leeds 36, and Liverpool 37·6, that of Hull was less than one-half the last named, 18·3. The average mortality of the borough is however not so favourable, as will be found hereafter.

By the time our readers have accompanied us to the end of our task, they will understand the feelings of pleasure with which we record the facts that the Hull Board of Health, presided over by the Mayor, is composed of energetic men, who have effectively organized themselves for sanitary purposes; that the night-soil of

the town is collected before nine o'clock in the morning, and deposited either close to the boundary, or in the case of the most important parish, Sculcoates, beyond the boundary, and the depôts are shortly to be still farther removed.

It is to be regretted, however, that there, as in all other large towns from which we have gathered information, it is not the practice to use disinfectants.

Hull was formerly ill-provided with water, but we believe its wants are now tolerably well met. Its low situation is very disadvantageous for sewerage, but, as far as we can learn, its arrangements in that respect are good. Very extensive drainage works are being carried on, and the sewers of the old town are flushed by the docks from which a sufficient fall is obtainable, and in the remaining parts of the town they are cleansed by the admission of the tide; the whole being periodically swept out.

Formerly the town had to suffer much from the boiling of whale-blubber, but with the departure of what was at one time its staple trade, the whale-fishery, the nuisance referred to has disappeared, and in its place the visitor experiences the healthy and not disagreeable odour of its numerous seed-oil and cake manufactories.

Let not the inhabitants, however, relax their exertions to keep their homes healthy, for even there it would not be difficult to point out unhealthy courts, alleys, and streets. Hull does not, however, suffer from any monstrous evil, or train of nuisances, which is more than can be said for *Bristol*.

There is no want of sanitary government at Bristol, but rather the reverse; and a certain old proverb concerning an excess of *chefs-de-cuisine* is verified. There is a Board of Health, and also a Committee of Health. The former constitutes the "Sewer Authority," and has performed much useful work in sewerage, the erection of drinking fountains, public boxes for the reception of refuse, &c. The other sanitary body, the "Health of Towns Committee," emanates from the Corporation of the Poor, and has an officer of health for the whole city with the somewhat meagre salary of 200*l.* or 300*l.* a-year; besides, there are subordinate health officers in each district, medical men, who, if we understand aright, have no salaries beyond those dependent upon their inadequate poor-law appointments. The Clifton Union have also appointed an officer of health for that district, with a separate salary.

The Health of Towns Committee is prompt and energetic in emergencies, such as visitations of typhus or cholera, but, as our readers will doubtless have anticipated, the two Sanitary Corporations here (as elsewhere under divided authority) are often at variance. And when this article was written it was found that the Privy Council order affecting towns such as Bristol, would create greater confusion and squabbling.

And well they may, for although Bristol does not at present show a high rate of mortality as compared with some large towns, its internal condition is such as to render it nationally dangerous, for it must not be forgotten that, like Liverpool, it is a large seaport at which vessels are continually arriving from foreign parts.

No hospital exists there for the reception of epidemic or contagious diseases. The Bristol Royal Infirmary and the Bristol General Hospital are authorized by their rules to refuse admission to all cases of this kind.

A temporary fever hospital was erected last year, but when typhus disappeared this wooden shed was demolished. A large building was placed at the disposal of the city by the liberality of one of the Corporation of the Poor (H. W. Green, Esq.) for the reception of cholera patients, but owing to the opposition of one of his tenants he was compelled to withdraw the gift.

Formerly, St. Peter's Hospital was devoted to the reception of medical cases, and was, in effect, the fever and lock hospital of the city; but on the day when the Corporation of the Poor became subservient to the Poor Law Commissioners, the citizens of Bristol lost the accommodation of St. Peter's as a public hospital; it is now a simple "Union."

We now approach a subject which, from its repulsive nature, has occupied but little of the attention of sanitarians, but which we believe to constitute one of the chief elements in the consideration of the mortality rate of large towns, namely, the removal of night-soil and refuse.

In Liverpool, at the time of the publication of our last article, a large portion of it was deposited on wharves, on the banks of the canal, and in the heart of the vast fever district of the borough; and although the local authorities managed not to see it in that light, there can be little doubt that the endemic typhus there has to a great extent resulted from that cause; or at least it tended largely to its maintenance.

In Bristol the night-soil is removed by the sewers; partly by the old systems, which are small and inadequate, and partly by the new sewers, not yet fully completed; and even where completed, they are not sufficiently brought into use, as the private sewers have not been extensively joined to the large common trunk sewerage canals. Many of the old sewers open into the river Froome, which runs through the city and even opens into the floating-harbour, which is a stagnant body of water, partly tidal, partly fresh, and in the very heart of the city, and at times most offensive from heat and decomposition of fœcal and animal matter. This water is changed *only once a fortnight*, even in summer time, and less often in winter. The commercial interests at stake prevent the change of this festering ditch being more frequent,

as the whole of the naval commerce of Bristol is dependent upon this floating-harbour.

The Froome has been an open ditch from the formation of this harbour, and is filthy in the extreme; it has been partially covered over within the past three or four years. In its vicinity the former outbreaks of cholera occurred and the fever nests of the city exist. The Froome is the principal cause of pestilence in Bristol, as it is a grand system of open sewage still in use, unfortunately, as it is at times nearly stagnant, and always foul. The new sewers open in two places into the tidal river Avon, and have no connection with the floating-harbour.

One at the Underfall Dam in St. Philip's, near the Great Western Railway Terminus, and the other below St. Vincent's Rocks. One (the first) will cause the sewage to pass through the New Cut, part of the Hotwells, and below Clifton, to mix with the second mass of fœcal matter and run to the Severn together, and both will render it liable to be *washed back* by the rising tide to Bedminster and other districts, and even into Cumberland Lock and Floating Harbour. It is the opinion of persons well qualified to judge on such matters, that a great mistake has been made here, and that the engineers of the work are to blame for this breach of hygienic laws. This extensive sewerage work has produced considerable disturbance of the ground, and in many instances has fatally damaged the wells of Bristol, some of which have become so highly charged with animal matter as to be extremely deleterious. But the Bristol waterworks have supplied most of these districts with a very pure river water, rising on the Mendip range of hills, generally sufficient for the demands of the public, except in the height of summer and in very dry seasons, when it fails sadly. At night, too, there is no supply even for fires until the company *turns it on!* When the reservoirs are full, there is sufficient pressure to send the water even to the top of Clifton, an elevation 280 feet above the sea level. The Bristol Waterworks Company should be compelled by Act of Parliament to considerably increase their sources of supply, and the landlords should also be compulsorily obliged to obtain an adequate water-supply from the Company for their various tenants, especially in the poorer districts, where the wells are shallow and bad.

No disinfectants are anywhere used to decompose the sewerage matters.

In addition to the local nuisance occasioned by the great open sewer, the Froome, there are many objectionable factories, all of which vomit forth volumes of smoke into the atmosphere, no provision having been made for the consumption of this material. The atmosphere is very impure from this circumstance, and at times impervious to actinic power.

There are some distilleries, which at times throw off large volumes of the vapour of fusel oil, when clearing their apparatus for a fresh charge; several sugar refineries, which poison the atmosphere with the disgusting odour of raw sugar during the blowing-up process; several tallow-chandlers and grease refineries, from which issue the vile odours of melted fat and animal matters in a state of decomposition.

Bone works are also present, whence the odours of burnt bones and fetid ammoniacal matters mix their repulsive stenches, poisoning the air for miles around; also chemical manufactories, whence sulphurous and hydro-chloric acids diffuse themselves far too plenteously into the winds of heaven, and from which the effluvia of waste black ash or soda waste emanate, creating great nuisances to all around their influence.

Then the gas-works add their quota of vile odours by discharging large quantities of fetid lime out of the purifying vats, which also sometimes poison the wells by furnishing hypo-sulphite of lime to the various mineral constituents of the springs.

The slaughter-houses, skin depôts, and various tanneries may also be added to the list of local nuisances, many of the latter existing along the line of the open Froome, and poisoning the neighbourhood by their open fleshing-pits for depilating the hides and skins. These being now within the boundary of the rapidly extending city should be all closed by the powers of the Board of Health.

In spite of all these causes of disease and mortality, the death-rate of Bristol has been very much lower than many of the other large towns of England, as shown by the Registrar's Weekly Returns.

Frequently the rate has been *one* of the lowest, sometimes not higher than 18 or 19, but 22 to 25 per 1,000 being the average mortality, which was only exceeded last year during a few weeks, when typhus got the better of the medical profession and the defective sanitary arrangements of the city.

The general impression which strangers invariably receive on visiting the city of Bristol, is the prevalent dirty condition of the streets and public walks. The dirty approaches to the city from the railway termini and the narrow crowded state of the principal thoroughfares, some of which are perfectly inadequate to take the streams of vehicles, and are often so blocked up that no traffic can pass. These are also lined by houses inhabited by the tradesmen and artificers of the city. Some of these thoroughfares are so narrow that it is possible to converse freely across the street from window to window, and in some portions even to shake hands easily from one side to the other out of opposite windows. These streets have not been altered since the days when all the traffic was conducted on pack-horses and mules.

Hence overcrowding of the population everywhere exists; small houses for working-men are scarcely to be met with, and lodgings are also over-filled. Children everywhere swarm the roads, alleys, and public squares; whilst the prevalence of low habits of intoxication amongst almost all classes of society adds fearfully to the illness of the population. Delirium tremens, jaundice, dropsy, Bright's disease, and various forms of mania prevail as the results of these fearful breaches of social morality.

A large and commodious lunatic asylum has already become over-filled, as the consequence of this prevalent source of lunacy, pauperism, and crime.

What the Liverpool and Leeds Canal is to Liverpool, and the Froome to Bristol, that the river Clyde is even, in a greater degree than either, to *Glasgow*—the magnificent city to which it should bring health as well as wealth—an open sewer, breeding disease and abetting death in the havoc which he commits amongst its population. But when we say that the Clyde is a more serious danger to Glasgow than similar receptacles of filth are to other large towns, it is not intended as a condemnation of those who have the guardianship of the public health in that city.

Until about four years ago, the Health Authorities of Glasgow scarcely had any real or defined existence; since then, however, there has been a very marked change for the better. The Police Board, consisting of one of the three Town Councillors from each of the sixteen municipal wards, may be said to be the executive. It has for several years embraced a Sanitary Committee, the Chairman of which, Mr. Ure, has fortunately been a man of much energy and common sense, and is, besides, much respected. One of his first acts was to urge, successfully, the appointment of a medical officer of health, so that there should, at least, be some probability that any recommendations which he might make would be founded on scientific principles. Dr. W. T. Gairdner had then lately come from Edinburgh to fill the Chair of Medicine in the University, and as he had made a name for himself as a sanitary reformer by his lectures on "The Public Health of Towns," and had, moreover, expressed an intention of practising only as a consulting physician, thus having some time at his disposal, he was offered, and accepted, the appointment of chief officer of health for the city of Glasgow.

Five more medical men were appointed at the same time, each to take active superintendence of a district as its medical officer of health, but to act under the chief officer.

Various other officials are concerned in working out the sanitary arrangements determined on by the medical staff, or rather by Dr. Gairdner, with the approval of the Sanitary Committee of the Police Board. The chief superintendent and district

superintendents of police have a certain amount of power in their hands, under the provisions of the Glasgow Police Act. They can order outside cleansing, such as in common stairs, closes, courts, lanes, together with the removal of nuisances; and they can prosecute before the police magistrates if their orders are not attended to. The city architect, who is superintendent of streets and buildings, is also concerned in the work, being consulted both by the medical and police staffs, and is the professional inspector in various matters incidental to the health of the town.

Thanks to the activity of the Chairman of the Sanitary Committee, and to the special qualifications which Dr. Gairdner has for the performance of the duties devolving on him, the sanitary arrangements of Glasgow are tolerably good. Nor is it the fault of the assistant officers if there is anything to complain of there on the score of public health. There, as elsewhere, *overcrowding* is found to be one of the most productive causes of epidemic diseases, and to keep this down the Police Act (1862) requires, in all houses of less than three apartments, an absolute minimum of 300 cubic feet of space for each person above eight years, and of 150 cubic feet for each person under that age, inhabiting the house. The law is enforced by the police through a particular system, indicated by tickets, and hence there are ticketed houses and others. In several sanitary districts of the city no houses at all have been ticketed; in others, very few; and in others, again, a moderate or very large proportion, according to considerations of public expediency.

So great has been the energy of the proper authorities that, in the 54 sanitary districts of the city, the following was the state of the ticketing system on the 31st January of this year:—

Houses overcrowded (that had been ticketed) . .		1,046
Containing individuals over 8 years . .	673	
" " under 8 " . .	1,509	
		2,182
Not overcrowded		12,526
Empty houses		252

This is independent of the common lodging-houses according to the Act. They are not ticketed, but are under such regulations as practically prohibit overcrowding. Comparing the vital statistics of some of the sanitary districts in different years, and these again with the ticketing statistics, it is found that it is quite possible, by legal interference, to do a good deal towards mitigating some of the worst evils connected with over-population; and it is satisfactory to note that in districts in which overcrowding and epidemic fever were previously very great, indeed for a long series of years, the fever rate has persistently declined as the number of overcrowded houses has diminished. In other districts of the city, having much

greater natural advantages of situation, and a much superior class of population, the increase of epidemic fever has kept pace with the overcrowding of the ticketed houses which has been permitted.

Glasgow is provided with water-closets to an extent that is quite unusual in large towns. In houses built within the last fifteen or twenty years, it is a very common thing to find one to each family inhabiting a house of three or even two apartments. As these all communicate with the Clyde by means of the sewerage, a large proportion of the fœcal matter finds its way into the river, no small part of which has actually to mix with the water of the harbour. The condition of the harbour for some years has, in consequence, been foul and noxious in the extreme.

Besides the water-closets, there are in Glasgow 122 public and 3,131 private conveniences. The first named are large iron structures, situated in various parts of the town, especially in the vicinity of the harbour, and in places of great public resort, as the Glasgow Green and the Parks. The private conveniences, to each of which twelve families, on an average, claim access (!) are situated in the back courts attached to the houses in the less respectable parts of the town. They communicate with the ash-pits or middens. Under ordinary circumstances, these privies and middens are said to be emptied frequently, always before they become inconveniently filled, and always at the depth of night. The contents are carted to one or other of several large public manure depôts on the outskirts of the city, either close to, or in the vicinity of, some railway line. From these depôts the manure is removed, at the expense of farmers who purchase it, by carts or railway waggons, into the country. When any particular spot is the seat of epidemic disease, the middens are immediately cleaned out, and the dung-steads are disinfected by chloride of lime, or chloride of zinc (Sir Wm. Burnett's disinfecting fluid). Carbolic acid and Condy's fluid are being tried just now. As far as it is possible to do so, the Glasgow authorities guard against the ill-effects of old-fashioned public and private conveniences and manure depôts, within or near the limits of boroughs; but they are infamous relics of a barbarous age; they are a disgrace to civilization; and no reasoning, no ameliorating action justifies their continuance.

The courts are thoroughly washed with water delivered by a hose, and it may be that the common stair is whitewashed with caustic lime. If the subjects of the epidemic disease, as fever or diarrhœa, be poor, it is very probable that the medical officer will order admission to the hospital lately erected, in a case of emergency, by the Police Board, because of the difficulty of obtaining admission for such patients into the fever hospital at the Royal Infirmary. The house where the disease existed is then taken possession of by the sanitary department; the bed and body clothes

are taken away, and thoroughly washed, and dried at a high temperature; the straw is also taken away and burned; and the house is fumigated and disinfected by means of chloride of lime and sulphuric acid. After the house is whitewashed and otherwise cleansed, the bed is supplied with fresh straw, and the clothes are returned. It may here be mentioned that the medical officers have power, under the new Police Act (1866), to enter suspected houses during an epidemic period, and inspect the sanitary arrangements, and if a condition of things exists that is favourable to the spread of disease, they can order renovating measures to be performed forthwith at the expense of the landlord. This liberty is not granted to the police officers, as in their hands it would be liable to be abused. It should also be mentioned that, for the proper working of the sanitary scheme, which is only now beginning to get into shape, each district medical officer has under him a person to whom is deputed a good deal of the house visiting. He is expected to be a person of some discretion and good sense, and *must have had typhus fever*. He should call daily on his superior to report and receive his orders. The medical officer is guided very much in his inquiries by the death entries which the Registrar for the district supplies to him daily. If he finds deaths registered from houses in suspected localities, and from no assigned cause, or from some epidemic disorder, as small-pox, scarlet, typhus, or typhoid fever, or diarrhœal diseases, measles, &c., his subordinate officer visits them immediately, prosecuting his inquiries, and, if need be, he calls in the services of the cleansing officials. It is not erring much, if at all, to say that the whole power of the police establishment is at the command of the medical officers of health to keep disease in check.

The foul condition of the river Clyde is undoubtedly the chief nuisance in Glasgow. It could be abated or entirely removed if the sewerage were entrapped and carried away from the city, as it might easily be, by special channels; but public opinion is scarcely ripe yet for that very radical measure, and zealous as the authorities are for sanitary reform, this is rather too great a leap for them to take. The authorities are disposed to wait a little, so as to see what result attends the London movement with respect to the Thames, before launching into any operations that would involve a great outlay of money. With all their zeal, they have not yet learned to appreciate the value of human life. There are, likewise, various chemical works engaged in the production of nuisances. The chief of these is the famous establishment of the Messrs. Tennant, at St. Rollox, in the north quarter. Alkali, bleaching-powder, soap, acids, &c., are made in it in immense quantities, and the sewage from it emits a horrible stench of sulphuretted hydrogen on meeting the liquid town sewage

in its course to the river.* The "Alkali Act," in the hands of Dr. Angus Smith, the Inspector, has been of some service in lessening the offensive character of the districts where the chemical works "most do congregate."

Whatever may be the hidden subtle influence which generates typhus, cholera, and such epidemic diseases, it is well known, from experience gained in Glasgow, that the condition of the dwelling-place and the condition of the body are intimately connected with the spread of disease. Overcrowding, bad ventilation, damp, darkness, and underground situation of dwellings, filthiness of the person, house, and places adjoining, are all conducive to the spread, if not to the origin, of epidemics. With this fact patent to them the municipal authorities sought, and have just succeeded in gaining, Parliamentary powers for carrying out a City Improvement Scheme, by means of which old houses in densely-peopled parts of the city will be razed to the ground, the lines of streets widened and straightened, and new streets formed where none have hitherto been. The purchase of the property required for these alterations will necessitate an enormous expenditure of money by the Corporation; but the citizens are wisely prepared to submit to an extra amount of taxation for a number of years, in the hope that the public health and the moral and physical condition of the people may be improved in a corresponding degree. The alterations in question will be effected where they are most needed, where disease, crime, and human wretchedness have for many years reigned supreme, and have continually shocked the moral sense of the well-to-do and better-disposed members of the community. By-and-by the mortality from epidemic disease will doubtless be much diminished when those improvements shall have been effected in Glasgow. A large portion of the excess of mortality is due to an unusually large infantile mortality; and the causes of death are in very many cases not registered, owing to the fact that medical men have not attended the patients during the fatal illness.

The mortality in Glasgow for 1865, as given by the Registrar-General, is 32·89, the number of deaths being about 14,000. Of these 3,166 are said to have been under 1 year of age, and 3,285 under 5 years!

These are sad facts. However, great praise is due to Glasgow for its energy in sanitary Reform, and no greater tribute could have been paid to its inhabitants than the mere mention by the Right

* It is but justice to say that the Messrs. Tennant have been at great expense to deodorize their liquid refuse, or rather to render it innocuous while passing through the town, for at first it is comparatively inodorous. They have had the professional services of eminent chemists, and they have constructed, at their own expense, a large sewer all the way from their works to the river, where the refuse is discharged.

Hon. H. A. Bruce, in his advocacy of his excellent Public Health Bill, of the circumstance that the city had voted over a million and a quarter for the purpose of rebuilding its courts and wynds!

Honour to Glasgow for its beneficent care for its defenceless and misguided poor!

Excepting the filthy condition of the Clyde, and the evils already referred to, there is little to be noted in the way of nuisances in Glasgow. The authorities, through the Sanitary Committee and Medical Officers of Health, are a-head of the ratepayers. The former scarcely need any stimulus from the latter. The inspectors of police and the Sanitary inspectors are about as lynx-eyed and keen-scented as it is desirable they should be, and they readily find out any external nuisances, that is, external to the places of abode. Anything that may escape the inspectors is most likely to be discovered by some indignant ratepayer, who forthwith makes his complaint publicly known. This is generally through the medium of the press, for in Glasgow they are a great newspaper-reading people. The complaint thus reaches the notice of the authorities, and if it is really a grievance, it is very soon remedied.

It is well to find such a facile mode of rectifying the abuses, or exposing the neglect of the Sanitary Authorities, but what we have said of Glasgow is unfortunately rather the exception than the rule, and the large and important town of *Leeds*, to which we shall now direct the attention of our readers, whilst it possesses one of the most influential Journals in the country, suffers under a sanitary executive of a totally different character; impressible only by the most energetic external action. The health of Leeds is supposed to be protected by the Town Council, whilst really what little is done in that direction emanates from the Board of Guardians, who are entrusted with the carrying out of the Diseases Prevention Act, and who usually proceed with tolerable vigour in periods of emergency. Probably they would have done more good for the town, had they not received a caution from the Privy Council last year, that they were acting beyond the law, and since that time they have confined themselves to their functions as a vestry.

But what shall we say of the Town Council, which through its Nuisance Committee, and Streets and Sewerage Committee, is supposed to be the sanitary executive in the borough?

There are upon these Committees, some individuals who are anxious to do what is right; but there, as in some other large towns, local "politics" form the active agent in the election of councillors, and the result is that knowledge, judgment, and modesty are supplanted by qualities of an opposite character.

The town is in a most discreditable condition as regards its back-lanes and alleys; the absence of connection between its houses and main sewers; its "becks," which are open and full of abominations.

The sanitary affairs of the town are supposed to be regulated by three Acts of Parliament, to which may now be added the much needed Sanitary Act of 1866. The last local Improvement Act gave power to appoint a medical officer, to provide open spaces for recreation, which are much needed in Leeds, to open out new streets, and to effect numerous other improvements.

The water-supply is very unsatisfactory. It is pumped up from the river Wharfe into large reservoirs and thence distributed to Leeds, but is contaminated by the drainage of Otley and other small neighbouring towns. Although it is well filtered and does not show much impurity on analysis, the public feeling is very strong against it, and steps are being taken to draw a supply from other sources.

Leeds suffers in a marked degree from all the nuisances with which our large towns are infested, to wit: Cellar dwellings; overcrowding, which has subjected it to serious outbreaks of typhus; insufficient conveniences, in same cases situated under the bedrooms; in other cases, twenty to thirty families use one convenience! And in others again, they have none at all! This is a wide-spread and repulsive evil in Leeds, demoralizing to the mind and injurious to the body.

The "becks" are miniature Clydes, but of course much more dangerous, containing dead dogs and refuse; and the river is also contaminated with the refuse of human beings and manufactories. The outlet of the sewage below the town is a shocking place; there the Cattle Plague commenced and there it obstinately continued.

Then there are "back to back" houses in great numbers; insufficient trapping of sewers, for want of water in dry weather, and the traps are generally choked up and useless. The sewers are imperfectly flushed, indeed it is a question whether they are ever flushed at all. Pigs are kept in large numbers in the town; the boiling down of fat, offal, &c., is also carried on within the boundary.

There is, as already stated, a great want of open places; many closed streets, alleys, squares, and *cul-de-sacs* need to be broken through, to provide circulation for the air, which does not now exist. The ashpits are inefficiently cleared; a large ashpit will sometimes be allowed to accumulate for six months or longer. The cleansing of the pavements is greatly neglected. Many houses, not cellars, are quite unfit for habitation, and those are often very much overcrowded with Irish. The lodging-houses are pretty well looked after; not so the public-houses and abodes of ill-fame. The supply of meat is insufficiently overlooked. Much very bad meat finds its way into the markets, which is said to pass muster on account of its appearance, whilst it has been found on the post-mortem examination of the animals to show evidences of disease.

A shocking cause of mortality in Leeds, another phase indeed of the same which exists in many of our large towns, is maternal neglect. In London, Liverpool, Manchester, and Glasgow there is a kind of legalized infanticide called "overlaying," where the mother gets drunk and smothers her child by lying down upon it in bed. In Leeds they are not quite so bad (although no doubt that accomplishment exists also); the mothers at work in the mills entrust their children to old women who feed them improperly and drug them to keep them quiet, which they do effectively.

Mr. Darnton Lupton, the ex-Mayor, has done much good through the establishment of a Working Man's Club; Dr. Allbutt has started a Labourer's Dwelling Company, Limited, and they have a Sanitary Association. A private individual, too, lately prosecuted the Corporation and compelled them to close their manure depôts, which until recently were fruitful sources of disease; and from this account of the state of the town, we think our readers will agree with us, that the Association has a wide scope for the exercise of its functions.

Hitherto we have had to deal rather with sins of omission than of commission on the part of our municipal bodies, but when we come to deal with the sanitary condition of the metropolis of the north of England, *Manchester*, we find a state of things calculated to make Englishmen blush with shame.

The health authorities of Manchester are the Town Council, and this body numbers amongst its members many kind, well-meaning, earnest men, who would like to see a radical reform in its mode of dealing with sanitary matters. There is a monthly visiting Committee, which inspects courts, alleys, and cellars, debates on their condition, and proposes action; but still a state of things exists—in fact an association of all the monstrous abuses to which we have referred in dealing with other towns—which horrifies tyros in the Council, and chokes their utterance; and so the world does not get to hear of the true causes of the unhealthiness which confers upon Manchester the second place in the mortality scale of our large towns.

No doubt the authorities will find apologists. They are kind to their equals, don't annoy their friends, and they are afraid of running the town into debt; so they save the money and sacrifice the lives of the ratepayers. Of course the dead cannot complain, and the burdens of the living are comparatively light. It is even whispered that the Corporation drive a lucrative trade in the refuse of the town, earning thousands by it. How can anyone be cross with such excellent political economists?

The mode in which they conduct their gigantic manure manufactory is as follows:—They have four manure depôts, *all within the city*. One in Water Street, two at the Railways, and one at

New Allen Street, and their manufacturing business is carried on partly in the streets of the town, at the houses in fact, and partly at these depôts. The nightmen pick over the contents of the ashpits when they empty them, wisely distinguishing between "rubbish" and "manure." The latter is conveyed to the depôts, the former is tipped *somewhere, anywhere* where it is permitted. Arrived at the depôts, the second stage of manufacture is performed. At one depôt slaughter-house refuse is mixed with it, and the stench there is perhaps as horrible as any that can be conceived on the face of this otherwise fair earth! The street-sweepings are also sorted. From certain streets (those paved with square-sets) they rank as "manure," which is stored, whilst that from macadamized streets is "rubbish," and is got rid of *somehow*. In order that the Corporation may carry on their business more snugly, they have purchased property about the depôts, so there is no chance of their own nuisance inspector finding them out and troubling them with summonses. As we have said, they drive a great trade. They have their travellers out on the main lines of railway and one in Cheshire who sell "on commission," and send home plenty of orders. Should the admiration of our readers for the Manchester Town Council make them anxious to have a transaction with them, we may mention that their dry manure may be purchased at 1*s.* 9*d.* and their wet at 1*s.* 3*d.* per cubic yard.

There are just sufficient water-closets in Manchester to pollute the water-courses, but not enough to make it worth the while of the Council to embark in a new line of business and sell the sewage. The rivers and canals are as fertile sources of disease as any of the other open sewers to which we have referred.

In many parts of the town the same deficiency of conveniences exists as in the other large towns, and the inhabitants are thus taught the filthy habits upon which they are afterwards lectured. There, as it might be expected, the smoke nuisance is very great, and adds to those already referred to. There are acres of houses which should be pulled down; badly-built cottages, where overcrowding is added to bad ventilation. A large proportion of the lower classes is, of course, as much addicted to drink there as elsewhere, and as they earn high wages, they have greater facilities for indulging in debauchery. In many cases their pleasures are unworthy of the name, and their money is squandered in momentary indulgences, whilst their houses are pig-styes and their families half-naked. Mr. Edward Brotherton we believe it is who states that education has retrograded in Manchester, and upon its decline a crowd of evils has arisen.

Of course we are not now condemning the whole labouring class; and if we were dealing with the other side of the question we should be able to adduce much that is noble and creditable. But

one thing is certain—lectures on Sanitary Science are worse than meaningless, and denunciations of filth, overcrowding, and drunkenness, rank hypocrisy, whilst the authorities themselves are the chief offenders against propriety, and, as in Manchester, consciously and obstinately so.

Whilst the Sanitary Act, 1866, was passing through Committee, private individuals were prosecuting and pressing the authorities of Leeds and Liverpool very hard, and they knew that as soon as the Act was passed appeals to the Home Secretary might be made against them; but the Leeds Town Council allowed the Bill to take its course, whilst that of Liverpool, through one of the Hon. Members for the Borough, expressed its cordial approval of the measure. But what did the Manchester authorities do?

One of the clauses of the Bill empowered private individuals to summon Nuisance Authorities before the magistrates if they failed in the performance of their duty; and, will our readers believe it? the Manchester Council formed a powerful coalition with other neighbouring municipal bodies and with persons in the House of Commons, who they thought would, through the political necessities of the Conservative Government, prove useful allies, and they sent a deputation to the Home Secretary to induce him, if possible, to withdraw this clause. They succeeded so far as to obtain a modification of it, the final appeal being now transferred to the Home Secretary! In a recent case, however, when an appeal was made to the Home Secretary to compel the authorities of Liverpool to discontinue a nuisance, he stated that recourse must *first* be had to the local magistrates, and his authority invoked only as a final appeal, so the Manchester gentlemen have succeeded in rendering the previously existing law more stringent and effective.

We doubt very much whether the good old town knows of these things, for the proceeding was very quietly conducted; if not, it will now be aware of the character of the "guardians of its health."

Before passing away from the consideration of the sanitary management of particular towns to the more general question of the means to be applied for enforcing reform, we would say a few words concerning mortality tables. The question of mortality must not be regarded in a partial manner, and it cannot yet be comprehensively considered. Outbreaks of some particular disease in one town will often exhibit its mortality rate to disadvantage for a time, and when the atmosphere is relieved, it may for a while appear to greater advantage than its sanitary condition would justify. For example, the death-rate of Bristol for the week ending March 17, 1866, was 40, that of Manchester 39. But Bristol was suffering from an attack of typhus, and for the whole year 1865, the death-rate of Bristol was 23·52, whilst in Manchester

the rate of mortality was 33·01 in 1,000! Again, the mortality rate of Hull in 1851 was 36, whilst in July, 1866, when the death-rate of London was 22, that of Hull was only 18. But the average of Hull is higher than that of London, as will be seen in the table below.

It is impossible at present to form more than a partial acquaintance with the rates of mortality in the large towns, as it is only recently that the registration has been placed on a satisfactory footing. Such as it is, however, it has enabled us with the aid of information kindly given to us by the Registrar General, to draw up the following table, indicating the relative sanitary changes in some of our large towns. The average annual mortality for each of the large towns named (excepting London) was correctly ascertained for the first time in 1865; and the mortality of those towns in 1851 is that of the registration districts in which they are situated. The last column shows the mortality when it was unusually high.

RATE OF MORTALITY TO 1,000 LIVING.

Towns.	Annual Average in 1851.	Annual Average in 1865.	Week ending March 17, 1866.
Bristol . . .	28	23·52	40
London . . .	24·44	23·39	30
Hull	25	27·27	34
Edinburgh . .	?	28·10	38
Leeds	28	30·95	38
Glasgow . . .	?	32·89	35
Manchester . .	31	33·01	39
Liverpool . . .	33	36·42	57

If it were quite fair to draw inferences from this table, it would appear that every town excepting Bristol and London has been becoming gradually more unhealthy; and we should be disposed to place great reliance even upon these imperfect data (for there is no doubt that that has been the tendency in our large towns), were it not for the apparent exception in favour of Bristol. The statistics of that city show that where insalubrious conditions exist (as they undoubtedly do there), as soon as an unhealthy season presents itself, the hand of disease grasps such a place, and the sanitary thermometer flies up almost to a level with the worst town in the kingdom. The causes are obvious; overcrowding, drunkenness, accumulations of filth, improper modes of disposing of the night-soil, imperfect conveniences at once tell their tale, and death stamps the vicious and neglected cities with his brand.

But the remedy for all this negligence, sin, and corruption is now at hand, and if the *Sanitary Act*, 1866, be not rigidly enforced,

either by Corporations, Societies, or private individuals, then the people of this country will richly deserve the severest calamities that can befall them. Hitherto they have had the justification of ignorance; now that is withdrawn from them, and the neglect of sanitary precautions becomes unpardonable.

The new Bill contains, briefly stated, the following provisions:

It enables "Sewer Authorities" to form themselves into Committees and to avail themselves of the assistance of ratepayers, by adding intelligent professional or other citizens to their number; to form special drainage districts for the purposes of the Sewage Utilization Act, and to collect the needful rate in such districts. It gives greater facilities for connecting outlying places with main sewers: Provides powers for the authorities to obtain a proper water supply.

With regard to nuisances: If the Nuisance Authority fail to discharge its duty, it gives power to the Home Secretary to employ the Chief Officer of Police, to "institute any proceeding which the nuisance authority of such place might institute with respect to the removal of nuisances."

It enables any ten inhabitants of a place to compel the removal of a nuisance, by a requisition to the authorities; with the same effect as would a certificate from the Medical Officer of Health.

It defines nuisances; overcrowded houses, factories, bakehouses which are uncleanly or so ill-ventilated as to render gases, vapours, dust or other impurities generated therein dangerous to health, or which are overcrowded. Smoky chimneys.

It defines the duties of "Nuisance Authorities." They must make periodical inspections for the purpose of enforcing the Act, must compel owners or occupiers of houses to cleanse and disinfect them and any articles they may contain, "*upon the certificate of any legally qualified practitioner*" that such cleansing and disinfection will tend to prevent or check infectious or contagious disease, and the Act gives them summary powers in case of the default of parties refusing to cleanse. It enables them to provide hospitals, houses for the disinfection of bedding, &c. &c., carriages for persons suffering from infectious diseases. To remove to the hospital (with the consent of the superintending body) persons suffering from dangerous infectious or contagious diseases. It makes it incumbent upon the authorities to remove and bury dead bodies.* It enables them to erect mortuaries for the reception of bodies to be subjected to post-mortem examination, and gives other powers and instructions on the same subject.

The Act further authorizes "Nuisance Authorities," with the

* Cases are not uncommon where the relatives of persons who have died of infectious or contagious disease, insist upon retaining the body in the house to the danger of their neighbours' lives.

previous sanction of the Secretary of State, to fix the number of persons "who may occupy a house or part of a house which is let in lodgings." To register houses thus let; to inspect them and enforce cleanliness; to enforce "the Provision of necessary accommodation in proportion to the number of lodgings and occupiers; the cleansing and ventilation of common passages and staircases;" "the cleansing and lime whiting at stated times of such premises." Where two convictions have taken place for breaches of the Act, within three months, the authorities may permanently close the unhealthy house.

The Act provides for the disinfection of carriages in which infected patients have been conveyed; and (by heavy penalties) against the exposure of themselves, by persons suffering from infectious diseases,* or of infected clothing, bedding, &c. &c.

It contains provisions to prevent the letting of a house or any portion of it, in which a dangerous infectious disorder has been, without its having been previously disinfected to the satisfaction of a qualified medical man; and, "for the purposes of this section, the keeper of an inn shall be deemed to let part of a house to any person admitted as guest at such inn." The penalty in this case is 20*l.* In cases of divided authority (as at Bristol, Leeds, &c.), the Privy Council may cause the Boards to act together, and may prescribe the mode of such joint action. The Act also provides summary and effective means for enforcing the periodical removal of manure and refuse matter from stables, mews, &c., upon a public notice being given; the penalty being twenty shillings per day, for every day the accumulation is allowed to remain beyond the specified time.

And finally, it contains stringent provisions for compelling the authorities themselves to perform their duty. Where a complaint is made to the Secretary of State, that any authorities have neglected their duty, either in regard to sewerage, water-supply, or removal of nuisances, he is empowered, "if satisfied after due inquiry made by him that the authority has been guilty of the alleged default," to make an order limiting a time for the performance of its duty in the matter of such complaint; and if they still fail to perform their duty, he may appoint some one to do it for them, and make them pay the expenses thus incurred, "together with the costs of the proceedings."

Having thus summarised the contents of the Act which affects the houses, habits, health, and comforts of almost every family in England, we would in conclusion say a word to our readers in regard to its application.

It is perfectly obvious that its usefulness will depend largely

* A shocking case of this kind is mentioned in our article on the "Predisposing Causes of Pestilence:" 'Journal of Science,' July, 1865, p. 388.

upon the action of the local authorities; and in case of default on their part, then its operation will have to be promoted by private individuals and sanitary associations, which should be at once formed wherever they do not already exist.

If we could be certain that Town Councils, Boards of Health, and other Local Authorities, would regard the Act as the herald of sanitary reform; would promptly, wisely, and unflinchingly give effect to its clauses, then nothing further need be said on the subject. But the experience of the past has taught us to expect different results; in fact the clauses directed against defaulting Authorities sufficiently indicate the views of the Legislature in that respect.

Much will therefore depend upon those watchful, self-denying men whose business it is to prescribe for the sick, whether in body or mind, upon medical men, ministers, and district visitors; and the first-named, especially, are now provided with a ready means of enforcing cleanly habits amongst their poorer patients. We advise all such persons to obtain a copy of the Act,* to peruse it carefully, and to do all that lies in their power to compel obedience to its provisions. Let them not be afraid of offending local authorities; they will find the Home Secretary prompt in responding to complaints, where the authorities are neglectful of their duty. Let them urge their wealthy and better educated parishioners and patients to take up the cry of sanitary reform; and let those also bring their means and energy to bear in the good cause.

If local authorities are desirous to avail themselves of the Act, let them not be over-confident. It seldom happens that they have amongst them scientific men able to guide them, but there are in every town intelligent professional men, who, although they may be retiring, and may have a distaste for municipal politics, will gladly give their advice and assistance to the Council of Health; and thus will be obviated those pitiful exhibitions of ignorance with which the world is sometimes astonished, and which have the effect of handing over the poorer classes to the mercy of quacks and pretenders ever watchful for their prey.

In all large towns it will be absolutely necessary to build healthy houses for the poor, who will be turned out of their wretched habitations by this Act; and in such towns it generally happens that the charities are maintained, and the philanthropic undertakings fostered by a very small proportion of the inhabitants. May these lines be read by some of those whose thoughts have not yet travelled into the realms of sympathy for the poor, and may they too give their aid and counsel in the good cause!

There is no apology necessary for the large amount of space which has been devoted to this subject; nor need we make excuses for the repulsive details which we have been compelled to notice.

* 'The Sanitary Act, 1866.'

It is not our fault that they exist, but being in existence it has been our duty to expose them. We fervently hope that the visitation from Above, and the legislation of man, may have the effect, once for all, of sweeping from amongst us the nuisances and unhealthy conditions which decimate our large towns; and may they inculcate lessons of morality, sobriety, and cleanliness in the minds of the people.

III. A NEW ERA IN ILLUMINATION.—WILDE'S MAGNETO-ELECTRIC MACHINE.

By William Crookes, F.R.S.

In the first number of this Journal an article "On Lighthouse Illumination by Magneto-electricity," was contributed by Dr. Gladstone. Nearly three years have elapsed since that time, and a very important result in this branch of Science having recently been obtained, it seems a fitting opportunity again to draw attention to the subject, as an introduction to our more immediate topic.

The experience of the last two or three years in the use of the electric spark in lighthouses has brought prominently forward several disadvantages and objections under which it labours. The advantages are many and obvious, and were well summarised in Dr. Gladstone's article, and were amply sufficient to justify the English Authorities in persevering attempts to introduce this light into practice. In 1855, while corresponding on this subject with the late Hydrographer to the Admiralty, Admiral Washington, Mr. T. Stevenson stated, "What we want is powerful apparatus, not intricate distinctions. To be enabled to see a light in a thick night, though it be only half-a-mile further than at present, may be of incalculable moment. If therefore we can increase the power of our lights so as to make them pierce the gloom but that fraction of a mile further than they do at present, we are moving in the right direction. On that small amount of extra offing, hundreds of lives may depend." It would appear as if the electric light was pre-eminently adapted to meet a case like this; but, recently, doubts have been thrown on its superiority over oil in penetrating fog. In 1865, Mr. Berthon, the Secretary to the Trinity House, said, that, for a limited range of from nine to ten miles, the electric is immensely superior to any other light, but beyond that distance it appears to lose in a great degree its power, until at eighteen or twenty miles it is not very different to any ordinary first-class light; and Mr. Stevenson likewise states, that at great distances the oil light maintains its power better than the electric. Such a phenomenon certainly seems

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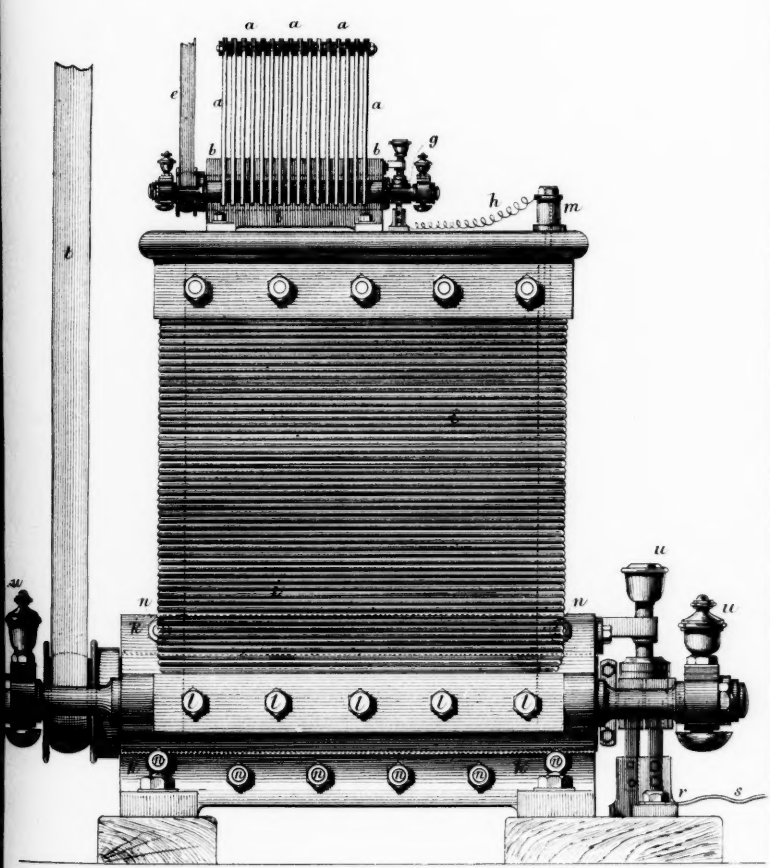

WILDE'S MAGNETO-ELECTRIC MACHINE.

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to be very improbable, although it may be the case that the rays proceeding from the electric light suffer so much more from absorption in passing through an obstructive medium than those from a flame produced by the consumption of oil, as to leave the oil light the more powerful of the two at great distances. If this were really so, it would follow that the application of the electric spark to light-house illumination is based upon a fallacy. The mere glare or splendour of effect to a near observer, so far from being an advantage to the mariner, is a positive evil, because, by its lustre, it tends to destroy his powers of perception of objects in the water that are nearer his view, and which therefore, from their proximity, threaten more immediate danger to the safety of his vessel. All the mariner requires is distinct visibility. The really useful power is that of penetration through an obstructing medium, and, therefore, the true measure of the usefulness of any light, is the distance to which it remains distinctly visible, and at which it preserves its characteristic appearance. This objection to the electric light has only been made within the last year or so, and is apparently irreconcilable with the statements respecting its brilliant visibility at great distances, upon which so much stress was laid on its first introduction.

Other difficulties have also been met with. The kind of knowledge and attention required to render the magneto-electric light constant and sure is far above that necessary with the most elaborate oil lamp; and the uncertainty to which the use of machinery of any kind is inherently liable, independently of the necessity of maintaining a constant supply of water, and the great difficulty of repairing and renewing the steam-engines and magneto-electric machines when required, all contrast most unfavourably with the certainty and simplicity attending the present oil lamp system. To this must be added the constant difficulty experienced in maintaining a class of persons for so responsible an office as that of engineer or attendant. A lighthouse, from its special nature, its great importance, its uninterrupted action, and its isolated position, is, in the language of Dr. Faraday, the last place to which processes comparatively new in their nature should be applied, if there be any other educational positions which can precede such application. Now, in spite of all the care which the importance of the subject has rendered necessary, the Dungeness electric light entirely failed or was inefficient for upwards of 119½ hours, between August, 1863, and October, 1864; and referring to this, the Elder Brethren of the Trinity House say that it appears to them to be impossible to obtain entire immunity from such accidents, so long as human nature is subject to infirmity. These fallings off and cessations have frequently rendered it necessary that the ordinary oil lamps should be lighted, and notwithstanding the power of the magneto-electric light, instances have occurred of vessels being

stranded near Dungeness. This liability to occasional failure is a matter for grave consideration in respect to the development of the magneto-electric light as an element of lighthouse illumination.

Under these circumstances the Elder Brethren stated on January the 18th, 1865, in answer to an inquiry from the Marine Department of the Board of Trade, that they are induced "to adhere to the opinion, expressed to their Lordships in their letter of the 8th April, 1863, that they are not prepared to recommend the adoption of the magneto-electric principle for lighthouse illumination." This opinion was repeated on the 15th of March, 1865, when the Secretary of the Trinity House wrote as follows:—

"There are numerous other causes of minor importance which have led the Elder Brethren to the decision expressed in my letter of the 18th January, which can only be duly weighed and appreciated by those on whom the responsibility of working, and, above all, of maintaining the lights is placed, and as already expressed in their letter of 8th April, 1863, the Elder Brethren feel that there are no advantages which can counterbalance the want of certainty in lighthouse illumination."

Meantime a somewhat modified system of illuminating lighthouses by electro-magnetic apparatus has been successfully exhibited at Havre, in France, and the Commissioners of Northern Lighthouses suggested that their engineer should be sent over to report upon it. It appeared that the plan adopted was very similar to that of Mr. Holmes, and that M. Berlioz had only made a few improvements upon it. Mr. Holmes being of opinion that he could now supply a better machine than the one in use at Havre, it was considered that it would be a national discredit and an act of injustice to that gentleman, if under these circumstances the foreign system were adopted. It was therefore decided at the latter end of last year that an entirely new system of apparatus, including lamp, machines, and engine, should be procured from Mr. Holmes; that the eminent optical engineer, Mr. James Chance, should be asked to put into practice certain opinions which he has always held respecting the size of the lens required, and the arrangement of curvature, he undertaking to supply an instrument which should be entirely suitable; whilst the Elder Brethren proposed to combine with this new apparatus a thoroughly independent system of management, which they trust may result in the establishment of the magneto-electric light as a useful component of lighthouse illumination.

Early in the present year, rumours of Mr. Wilde's new electro-magnetic apparatus were first heard, and Mr. Thomas Stevenson was instructed to visit Manchester to report on the same. He was so very favourably impressed with the apparatus, that it was considered indispensable to a proper series of experiments, that it should be tested along with Professor Holmes's. An estimate was

accordingly obtained from Messrs. Wilde, and their offer was at once accepted.

The light from Messrs. Wilde'sl arge machine, which Mr. Stevenson saw, is the most powerful artificial light which has ever been produced, giving about eight times the light of the magneto-electric machines now in operation, and it was therefore not considered desirable to suggest the use at present of that sized machine for light-house purposes. A machine about half the power of the large one was recommended, as by a simple arrangement the brilliancy of the light, and the power required to drive the machine, could be varied at pleasure, to suit the different conditions of the atmosphere, and with it requirements could be met which would be beyond the power of any other description of machine. The dimensions of such a machine would be—length 64 inches, width 20 inches, height 48 inches, and the cost 1,000*l*. Ultimately a machine of half this power, to cost 500*l*., was decided upon, and when the writer had the plea. are of visiting Messrs. Wilde's workshops, and the advantage of listening to the inventor's lucid description of his large machine, the one being made for the Commissioners of Northern Lighthouses was far advanced towards completion.

Like most practical applications of science, the important results which Mr. Wilde has obtained, depend more upon an ingenious combination of several known facts, united with considerable engineering skill, than upon any really new and striking discovery in the science. The principle of the machine can be expressed in a few words. It consists in the application of the current from an electro-magnetic machine, armed with permanent magnets, for the purpose of exciting a powerful electro-magnet; this electro-magnet being now used as the basis of a still larger electro-magnetic machine, for the purpose of having induction currents generated by its agency. In other words; by well-known means, an electric current can be obtained by the rotation of an armature close to the poles of a magnet. If this electric current be passed round an electro-magnet, it may be made to produce a far greater amount of magnetism than was possessed by the first magnet. There is no difficulty, therefore, in comprehending how, by the mere interposition of a rotating armature, and the expenditure of force, a small and weak magnet may be made to actuate a very powerful magnet. But as the power of the magnet increases, so does the power increase of the electric current which may be generated by induction in an armature rotating between its poles. We have therefore only to pass this No. 2 induced current from No. 2 magnet round a still larger magnet No. 3, and by rotating an armature between its poles we can get a still more energetic induced current No. 3. Theoretically there is no limit to this plan; it is a species of involution; and when it is considered that each conversion from magnet No. 1

to Magnet 2, &c., or from induced current No. 1 to induced current No. 2, &c., multiplies the power very many times,* it will not be considered surprising that after three involutions the induced current possesses such magnificent powers.

Some erroneous opinions are pretty generally entertained as to the actual discovery claimed by Mr. Wilde, and the splendour of the result, for achieving which he deserves the very highest credit, is liable to cause earlier investigators in the field to be overlooked: this would be most unfair, for it is through their instrumentality that the way has been paved for the success now achieved. In 1838 the Abbés Moigno and Raillard† proved that by taking an electro-magnetic machine, the original magnet of which would only support a few grammes, and passing the electric current generated by it round a large electro-magnet, the latter could be made to support a weight of 600 kilogrammes. The Abbés carried the multiplication of power only so far as to obtain the more powerful magnet No. 2 from the weak magnet No. 1.

Electro-magnets of extraordinary power, with coils arranged longitudinally instead of transversely on their armatures, had been made by Mr. Joule. Magneto-electric machines with revolving armatures, in which electro-magnets had been substituted for permanent magnets, had been constructed by Dr. Page and Professor Wheatstone. Magneto-electric machines had been made to act on electro-magnets in various telegraphic instruments by Wheatstone, and subsequently by others; and Dr. Page, as well as the experimentalists above mentioned, had observed the important fact that an electro-magnet excited by a magneto-electric machine became capable of effects greatly exceeding those of the original magnet. The peculiarly constructed armature employed by Mr. Wilde is likewise essentially identical with Siemens' helix, a full description of which may be seen in Siemens' patent, and also in the fifth volume of Du Moncel's 'Applications de l'Electricité,' page 249, published in 1862. It is, however, right to say, that Mr. Wilde, in his patent of February 25, 1863, expressly states that he makes no claim to the peculiar construction of the armature.

By the kindness of Mr. Wilde we are enabled to give our readers a full description, with drawings, of the machine now in process of manufacture for the Northern lighthouse. Fig. 1 represents a side view, and Fig. 2 an end view of the machine; the letters referring to the same parts in each: *a a a a a* are 16 permanent magnets, bolted on to the magnet cylinder *b*, shown in magnified section at Fig. 3. The magnets weigh about 3 lbs. each, and will support a weight of about 20 lbs. In the magnet cylinder the part *b b* is

* We say very many, but we have absolutely no data to guide us to a near approximation.

† Moigno's 'Télégraphie Électrique,' p. 15. Paris, 1849.

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Fig. 2.

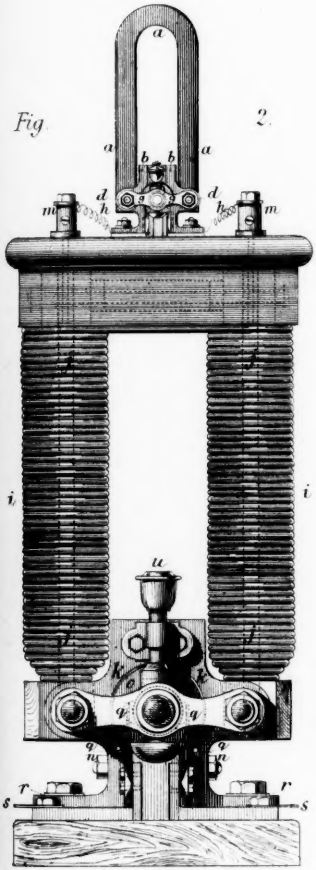


Fig. 3.

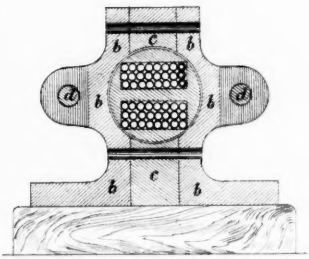
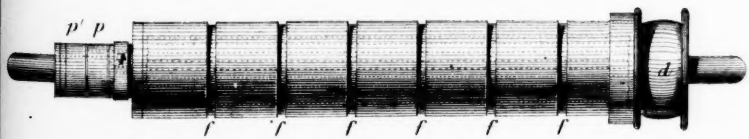


Fig. 4.



M & N Hanhart lith.

WILDE'S MAGNETO-ELECTRIC MACHINE.

iron, and *c c* brass, and it is so arranged that *b b*, being screwed on to the respective poles of the magnets at *d*, form one entire north pole and one entire south pole to the 16 magnets, separated from each other by the brass pieces *c*. A circular hole, $2\frac{1}{2}$ inches in diameter, is bored lengthways through the metals, so as to form them into a hollow cylinder of brass and iron. Fig. 4 represents the armature; a transverse section of which is also shown in its place inside the hollow cylinder, Fig. 3. It consists of a cylinder of cast-iron, about one-twentieth of an inch less in diameter than the hole in the cylinder *b*, *c*, *b*, *c*, so that it may revolve in very close proximity to the interior of the hollow cylinder without touching it; being held at each end by appropriate brass supports, in which the axis of the cylinder works. At one end of the armature is a cylindrical prolongation *d*, on which a pulley *e* works, and at the other end is fixed a commutator. About fifty feet of insulated copper wire, one-eighth of an inch in diameter, are wound upon the armature in the direction of its length, as shown in Fig. 4, and in section in Fig. 3. The inner extremity of the wire is fixed in good metallic contact with the armature, the other end being connected with the insulated half of the commutator. Bands of sheet brass, *f f*, are bound at intervals round the armature, in grooves sunk in it for that purpose, their object being to prevent the convolutions of insulated wire from flying out of position by centrifugal force when in rapid rotation.

By means of the small strap *e*, the armature is made to revolve in the interior of the magnet-cylinder at about 2,500 revolutions per minute. During each revolution, two waves of electricity, moving in opposite directions, are induced in the insulated copper wire surrounding the armature. The rapid succession of alternating waves thus generated at the rate of 5,000 per minute are, by means of the commutator at *g*, converted into an intermittent current moving in one direction only, which is conducted along the wires *h*.

The electro-magnetic machine by which the light is produced is of precisely the same construction as the magneto-electric machine just described, except that an electro-magnet *i* is substituted for the permanent magnets *a*, *a*. The electro-magnet *i*, Figs. 1 and 2, is formed of two rectangular plates *j*, of rolled iron, 36 inches in length, 26 inches in width, and 1 inch in thickness, as shown by the dotted lines. They are bolted, parallel with each other, to the sides of the magnet cylinder *k* by means of the bolts *l*, and the plates are connected together at their upper extremities, by being bolted to a bridge formed of two thicknesses of the same iron as that of which the sides are made. All the component parts of the electro-magnet, requiring to be fitted together and to the magnet cylinder, are planed to a true surface, for the purpose of ensuring intimate metallic contact throughout the entire mass.

Each of the sides of the electro-magnet is coiled with an insulated conductor, consisting of a bundle of seven No. 10 copper wires, laid parallel to each other, and bound together with a double covering of linen tape. The length of conductor coiled round each side of the electro-magnet is 1,650 feet. Two of the extremities of the coils are connected together so as to form a continuous circuit 3,300 feet in length; the other extremities of the coils terminate in the two insulated metal studs *m m*, fixed upon the wooden top of the machine, and connected thereby with the wires *h h*. The total weight of the two coils of insulated copper wire, without the iron, is half-a-ton. The diameter of the hole in the magnet cylinder is 7 inches, and its length 35 inches. The separate parts of the cylinder are bolted together at the top and bottom by means of twelve copper bolts *n*, three-quarters of an inch in diameter. The armature *o*, which is an exact fac-simile, except as regards size, of the one already described, is about one-eighth of an inch less in diameter than the bore of the magnet cylinder. It is wound with an insulated strand of copper wire, 350 feet in length and a quarter of an inch in diameter, as shown in section in Fig. 3. A pulley *d*, 7 inches in diameter, is keyed upon one end of the armature, and upon the other end are fixed two hardened steel collars *p*, *p*^{1}, one of which is insulated from the armature axis. These form part of the commutator, by means of which the rapidly alternating currents are converted into an intermittent current moving in one direction only. These currents of electricity, which produce the light, are taken from the steel collars by means of the springs *q*, *q*, and thence to the screw nuts at *r*, from which they can be conveyed to any place required by the conductors *s s*.

The armature of the 7-inch machine is driven at 1,800 revolutions per minute by means of the strap *t*, from the same shaft as the magneto-electric machine. Reservoirs for oil are shown at *u*. The total weight of the machine complete is a little more than 1 ton.

The action of the machine will be readily comprehended from the explanation previously given. The electricity induced from the permanent magnets *a a a*, in the rotating armature of the small machine is transmitted, by means of the wires *h h*, through the coils of the large electro-magnet of the 7-inch machine, the iron plates and magnet cylinder of which acquire an enormous amount of magnetism. Simultaneously a proportionately larger amount of electricity is induced in the wires of the larger armature, and this current of electricity is used for producing the light. When the machine is in full action, an engine of about three-horse power will be required to drive it, and the lamp will consume sticks of carbon at least $\frac{3}{8}$-inch square. The power of the machine may be regulated according to the quantity of light required to suit the different

conditions of the atmosphere, by placing small blocks of iron on the top of the small magnet cylinder *b b*, so as to connect the opposite poles, and proportionately diminish the power of the induced current in the armature.

This machine is, as already mentioned, considerably smaller than the one now in existence. In the former there are only two conversions, that is to say, a permanent magnet—an induced current of electricity—an electro-magnet—a more powerful induced current. In the large machine there is a still further multiplication of force. Its small magneto-electric machine has an armature of 1⅝-inch diameter, armed with six small permanent magnets weighing 1 lb. each. The induced current from this is transmitted through the coils of the electro-magnet of a 5-inch * electro-magnetic machine, and the direct current from the latter is simultaneously, and in like manner, transmitted through the coils of the electro-magnet of a 10-inch machine. The weight of the electro-magnet of the 10-inch machine is nearly three tons, and the total weight of the instrument is about 4½ tons. The machine is furnished with two armatures—one for the production of "intensity" and the other for the production of "quantity" effects. The intensity armature is coiled with an insulated conductor, consisting of a bundle of thirteen No. 11 copper wires, each 0·125 of an inch in diameter; the coil is 376 feet in length, and weighs 232 lbs. The quantity armature is enveloped with the folds of an insulated copper-plate conductor 67 feet in length, the weight of which is 344 lbs.

With the three armatures driven at a uniform velocity of 1,500 revolutions per minute, an amount of magnetic force is developed in the large electro-magnet far exceeding anything which has hitherto been produced, accompanied by the evolution of an amount of dynamic electricity from the quantity armature, so enormous as to melt pieces of cylindrical iron rod fifteen inches in length and fully one quarter of an inch in diameter, and pieces of copper wire of the same length and one-eighth of an inch in diameter. With this armature in, the physiological effects of the current can be borne without inconvenience; immediately after fifteen inches of iron bar had been melted, the writer grasped the terminals, one in each hand, and sustained the full force of the current. The shocks were certainly severe, but not inconveniently so.

When the intensity armature was placed in the 7-inch magnet cylinder, the electricity melted 7 feet of No. 16 iron wire, and made a length of 21 feet of the same wire red-hot. The illuminating power of the current from this armature was of the most splendid description. When an electric lamp, furnished with rods of gas carbon half-an-inch square, was placed at the top of a lofty building, the light

* For the sake of convenience, the different sized machines are distinguished by the calibre or bore of the magnet cylinders.

evolved from it was sufficient to cast the shadows of the flames of the street-lamps, a quarter-of-a-mile distant, upon the neighbouring walls. When viewed from that distance, the rays proceeding from the reflector have all the rich effulgence of sunshine. With the reflector removed from the lamp, the bare light is estimated to have an intensity equal to 4,000 wax candles. A piece of ordinary sensitized paper, such as is used for photographic printing, when exposed to the action of the light for twenty seconds, at a distance of 2 feet from the reflector, was darkened to the same degree, as a piece of the same sheet of paper was when exposed for a period of one minute to the direct rays of the sun at noon on a very clear day in the month of March. The day on which the writer saw the machine at work (towards the end of June), the mid-day sun was shining brightly in at the window. He took the opportunity of roughly comparing the intensity of the sun, with that of the electric light armed with the reflector. From a comparison of the shadows thrown by the same object, it appeared to him that the electric light had between three and four times the power of the sun light. That the relative intensities were somewhat in this ratio, was evident from the powerful scorching action the electric light had on the face, and the ease with which paper could be set on fire with a burning-glass introduced in the path of its rays.

The extraordinary calorific and illuminating powers of the 10-inch machine, are all the more remarkable from the fact that they have their origin in six small permanent magnets, weighing only 1 lb. each, and only capable at most of sustaining collectively a weight of 60 lbs. When working up to its full intensity, it requires an engine of about 7-horse power to drive it.

The physicist will, at first sight, consider that the intimate connection between the consumption of so large an amount of mechanical power, and the evolution of so enormous an electrical force, is a necessary consequence of the modern doctrine of the conservation of force. But, without for a moment denying the truth of this doctrine, it must be admitted that there are certain phenomena connected with this machine, which are in apparent contradiction to the law of conservation.

A phenomenon already obtained on a small scale by Jacobi, Lenz, and Miers, is rendered visible in the most striking manner by means of this machine. When the wires, forming the polar terminals of the small exciting magneto-electric machine, were connected for a short time with those of the large electro-magnet, and then disconnected, a bright spark could be obtained, from the wires of the electro-magnet, twenty-five seconds after all connection with the magneto-electric machine had been broken.

It will be of interest, apart from all questions as to economical production, to ascertain what is the theoretical quantity of coal

required to be consumed in the production of this amount of electric force. Mr. Wilde says that a 7-horse power engine is required to drive the machine. One-horse power is equal to 1,980,000 foot-pounds per hour; that multiplied by seven is 13,860,000 foot-pounds per hour, which therefore represents the actual power required to drive the machine. Now, by multiplying the British Fahrenheit units of heat, produced by the combustion of one pound of coal, by Joule's equivalent, or 772 foot-pounds, the result will be the total heat of combustion expressed in foot-pounds. In the best coal this is as high as 12,000,000 foot-pounds. We arrive therefore at the startling conclusion, that, to overcome the friction of the different parts of the machine; to whirl a mass of metal, weighing several hundred-weights, round with a velocity of 1,500 revolutions per minute; to generate a current of electric force far surpassing anything ever before produced; and, after allowing for the waste inherent in its passage through the conducting wires and electric lamp, to cause it to blaze forth with an intensity of light, before which the rays of the sun himself appear pale and feeble; to keep up this intense development of energy for one hour, requires an expenditure of force represented by the combustion of less than $18\frac{1}{2}$ ounces of coal!

This is the theoretical calculation; but if reduced to actual practice, the results are scarcely less astonishing. The economy of the power actually employed by Mr. Wilde cannot be calculated, as the engine is a 60-horse one, and is used for driving the very heavy machinery of a wire mill, as well as performing the various operations required in an engineer's workshop; but the *efficiency* of an engine, *i. e.* the ratio of the work actually performed to the mechanical equivalent of the heat expended, is well known, and varies in extreme cases between the limits 0·02 and 0·2. Taking an average efficiency as 0·1, or one-tenth, we find that the ordinary consumption of coal required to work a 7-horse power engine, midway between excessive wastefulness on the one hand and rigid economy on the other, is $10 \times 18\frac{1}{2}$ ounces or $11\frac{1}{2}$ lbs. of coal per hour, worth about one halfpenny.

The above expense of one halfpenny per hour for coal is of course only one item in the cost,—to it must be added the expense of carbon rods for the lamp, which will be about ten inches per hour, worth perhaps a penny; there must also be added interest of the cost of purchase of machines, expense of maintenance and repairs, which will perhaps bring up the total expense per hour to sixpence or eightpence. Comparing this with the hourly expense of the electric lights already in existence we find, according to the Abbé Moigno, that the French machine costs altogether sixpence per hour for a light equal to 900 wax candles, whilst the actual working expenses of maintaining the electric light at Cape La Hève

during a period of twenty-seven months have been, exclusive of salaries, about one shilling per hour, or inclusive of salaries, two shillings.*

According to a calculation made by the Abbé Moigno respecting the economy of the light evolved by the French machines, and altering the figures to suit the present case, it appears that to maintain a light equal to 4,000 wax candles for one hour, would cost, with gas, 1*l.* 2*s.* 6*d.*; with Colza oil, 1*l.* 7*s.*; and with the electricity produced by a Bunsen's pile, 1*l.* 15*s.* 6*d.*

The annual expenditure at a first-class lighthouse, on the old system, is on an average 400*l.* per annum, and on the assumption that the light burns for 4,000 hours per annum. that would come to two shillings per hour. The expenses of the old and the electric system are therefore not very dissimilar, and the problem of the adoption of electricity to supersede oil, must be decided on grounds of convenience and efficiency alone.

The great advantage of Mr. Wilde's over the old system of magneto-electric machine, appears to be that it is capable of amplification to any required power, by a mere enlargement of the size of the different parts. His largest machine weighs about three tons. If, instead of using the electric current generated by it to produce dynamic effects, we pass it round a still larger electromagnet, we should at once produce a vastly greater development of force. The only limit which we see to this multiplication of power, is the excessive heat which would be developed in the rotating armatures. It would be an interesting problem to calculate what would be the result of driving the 32-inch armature, required for a 100-ton magnet, with (say) a 1,000-horse power steam-engine. If the power generated by this machine did not at once burn up the working parts, dissipate the electric lamp and conducting wires with a mighty explosion into space, and strike dead all the attendants with one lightning flash,—if it were at all manageable, and were put on a high tower, it would probably give light enough to make London by night considerably brighter than London by day.

Space will not admit of the enumeration of all the uses to which so convenient and economical a light may be applied. Moreover, this is a subject which has been so frequently discussed that any enumeration here would become a mere repetition. One practical application has however been made, which possesses great interest. Photographers are finding that it is more convenient than the sun. According to the 'Photographic News,' we learn that an establishment has been organized at Manchester, in which is fitted up the first of Mr. Wilde's machines for supplying the electric light. By the aid of this, more than two hundred negatives can be ex-

* 'Mémoire sur l'Éclairage et la Balisage des Côtes de France,' par M. L. Reynaud, p. 149. Paris, 1865.

posed in a day, to secure gelatine reliefs. This is the first practical application of the electric light to the commercial working of photography, its constancy rendering it here more valuable than an uncertain sunlight.

The purely scientific interest of this discovery has been scarcely touched upon. Of this more will be said hereafter. To physicists and experimentalists in magnetism the gigantic magnetic force developed in the three-ton magnet will afford an opportunity, which will doubtless at once be seized, of repeating and extending the classical researches of Dr. Faraday in Diamagnetism and the Magnetic Condition of all Matter.

IV. ADAMS' RECENT ASTRONOMICAL DISCOVERY.

By Richard A. Proctor, B.A., F.R.A.S.

If our earth, like the three other planets revolving within the zone of asteroids, had been without a satellite, mankind would in all probability have remained for ever in ignorance of the great yet simple law of universal gravitation. *Now*, indeed, that the discovery of the law has led to such vast progress in observational astronomy, and to so great an extension of the methods of infinitesimal analysis which alone enable mathematicians to deal successfully with the profound problems of physical astronomy, we know that the motions of the planets afford available and sufficient means of testing and establishing the theory of gravitation. But even to Newton's gigantic intellect the task of *founding* the theory upon such evidence alone would have been too vast. Conscious of this, we find him again and again impressing upon Flamstead the necessity of supplying him with lunar observations sufficient in number and accuracy to afford the necessary evidence in favour of the theory he wished to establish.

And as the moon afforded such important assistance when the theory of gravitation was first founded, so a careful comparison of the lunar movements with those which result from theoretical considerations has led to many valuable discoveries. Our determinations of the most important astronomical elements, *viz.* the magnitude, mass, and figure of the earth, and its distance from the sun and moon—"elements," says Laplace, "the knowledge of which had been the fruit of long and troublesome voyages in both hemispheres"—have received most important corrections or confirmations from exact methods of astronomical investigation applied to the lunar motions. It seems not unlikely that by the same means a yet more important element, the length of the sidereal day, which has

been hitherto recognized by astronomers as the "one constant element," may be found to be no exception to the system of perpetual variation and fluctuation ruling elsewhere throughout the universe. It is not indeed precisely in this aspect that the great discovery we are now about to examine has been presented by its author. But this result, if, as appears probable, it should be established as the legitimate consequence of Adams' discovery, would undoubtedly be its most important fruit, and in the words of the late President of the Royal Astronomical Society, would deserve "to be ranked amongst the most important contributions to astronomical physics."

A lunar theory having been formed and its accuracy tested by careful observation of the lunar motions for a considerable length of time, it became practicable not only to predict the moon's motions and position at distant future epochs, but to determine with equal accuracy the motions and position of the moon at long past epochs. Now, in general, it would be a matter of great difficulty to ascertain whether these last-mentioned determinations coincided with the real motions of the moon in past times; for the observations of ancient astronomers were neither effected nor recorded with the accuracy requisite for such a comparison. But in eclipses of the sun and moon we have phenomena so marked and striking as to be almost independent (so to speak) of observational inaccuracy save of the grossest kind. Accordingly very early in the history of gravitation, only six years indeed after the publication of the 'Principia,' Halley pointed out the valuable results which would accrue from an examination of ancient eclipses recorded by Ptolemy and by the Arabian astronomers. He expressed also the opinion that the result of such a comparison would be to show that the moon was now moving with a greater angular velocity round the earth than she had moved with at the epoch of the earliest recorded observations. Dunthorne, in 1749, communicated to the Royal Society a paper in which, after comparing the observed and computed times of several lunar and solar eclipses, he expressed the opinion that the acceleration may be expressed by $10'' t^2$, where t denotes the number of centuries before or after the fixed epoch from which the reckoning is supposed to commence. Mayer, in his lunar tables published in 1753, made the acceleration $6'' \cdot 7$ in a century; but in 1770 he raised his estimate to $9''$. Lalande, Bouvard, and Burg arrived at results confirming those deduced by Dunthorne and Mayer.

The explanation of this peculiarity of lunar motion was not found to be an easy matter. Euler and Lagrange in turn attacked the problem without success: the former, in 1772, expressing as the result of his analysis that the secular inequality is not caused by the forces of gravitation; the latter, in 1774, concluding that the best solution of the difficulty is to deny the existence of the

irregularity altogether. It is somewhat singular that in 1783 Lagrange, after discussing the effects of perturbing forces on the mean motions of the planets, stated it "as a truth rigorously demonstrated, that the mutual attraction of *the principal planets* cannot produce any sensible alteration in their mean motions." Had it occurred to him to apply his formulæ to the moon, to determine whether a similar freedom from secular inequalities exists among *the secondary planets*, he would not have had the mortification of seeing his gifted rival, Laplace, reap the honour of solving a problem which for ninety years had baffled the mathematical world.

Laplace first convinced himself that the records of ancient eclipses fully proved the existence of the secular inequality in the moon's mean motion. He then suggested three possible solutions, *viz.* that the phenomenon is due (i) to a continual retardation of the earth's diurnal motion, or (ii) to the existence of a resisting medium, or (iii) to the non-instantaneous transmission of gravity. Not satisfied with any of these solutions, he sought again and again to detect in the sun's disturbing action the source of the moon's secular acceleration; but unsuccessfully, until 1787, when he was able to announce that the true cause of the phenomenon lies in the secular variation of the eccentricity of the earth's orbit. To show how this happens it will be necessary to discuss briefly the important inequality called the *annual equation*, with which the minor inequality we are considering is most intimately connected.

Remembering that the sun's disturbing effect on the moon's motion is measured by the *difference* of his effects on the earth and moon, it will be evident that when the moon is in *syzygy* (that is, "new" or "full"), the attraction between the earth and moon is diminished, since the attraction of the sun on the nearer of the two bodies is greater than his attraction on the farther; but that when the moon is at or near either *quadrature* the attraction between the earth and moon is increased, since lines drawn from the sun to the earth and moon are nearly equal, but inclined at an appreciable angle. Now of these two disturbing effects the former is much the more powerful, since it is due to *inequality of distance*, while the other is exercised only through the effect of a minute *obliquity of pull*. And estimating the disturbing effects through a complete lunar revolution, it appears from similar considerations, that, on the whole, *the effect of the sun's action is to diminish the earth's attractive influence over the moon.*

Now any diminution of the central force which retains a body in its orbit is necessarily accompanied by an increase in the major axis of the orbit of the disturbed body. Accordingly the moon takes a longer period in accomplishing each revolution around her primary than she would but for the sun's disturbing influence. If

this influence were constant, so also would the moon's mean motion be constant. But it is clear that when the earth is in or near perihelion, the sun's disturbing effect must be greater than when the earth is in or near aphelion. Hence arises the *annual equation*, the effect of which is that the lunar month is longer in our winter than in our summer, the moon's orbit attaining its maximum dilation in January (when the earth is near perihelion), and its maximum contraction in July. The period of the inequality is an anomalistic year, and its maximum amount is 10′, by which the moon is sometimes before and sometimes behind her mean place.

Now since the *annual equation* is due to the variation of the sun's disturbing influence from the mean value it would have if the earth's orbit were circular, it is clearly possible that any variation in the eccentricity of the terrestrial orbit would, besides affecting the amount of the annual *equation* (which it would inevitably do), affect the total amount of the moon's motion in successive anomalistic years. But the eccentricity of the earth's orbit has been continually diminishing since the date of the earliest recorded observations; and since the major axis of the orbit has throughout remained appreciably unaltered, the absolute extent of the ellipse in which the earth moves has been continually increasing, so that the probability prior to exact investigation is that, owing to this cause, the sun's disturbing action has been diminishing, and therefore the earth's influence, and with it the moon's mean motion, increasing.*

It will be as well to state the actual extent of the ellipticity of the earth's orbit, as some misconception appears to prevail on this point, and in works on astronomy reference is continually made to this feature, as if it were much more marked than it is in reality. Assuming the earth's mean distance from the sun to be 91,500,000 miles, her least distance is somewhat under 90,000,000 miles, her greatest somewhat over 93,000,000; the centre of her orbit being 1,533,600 miles from the sun. Thus the *eccentricity* of her orbit though small is appreciable. The *ellipticity* of her orbit, however, is quite insignificant by comparison. For the major axis of the orbit is 183,000,000 miles, and the minor axis 182,974,000 miles, the difference being less than one-7,000th part of either dimension, so that a finely drawn circle one foot in diameter would differ from a correct representation of the earth's orbit by less than the thickness of its own bounding line. Again, the eccentricity of 1,533,600 miles is subject to an annual diminution of 40 miles, owing to which change the semi-minor axis undergoes an annual increase of

* It does not *necessarily* follow, from the increase of the minor axis, that the average distance of the earth from the sun would be increased. The lagging of the earth near aphelion, and her rapid motion near perihelion of the more eccentric orbit *might* be more than sufficient to compensate for the smaller absolute extent of that orbit. Examination proves the contrary; but it is not to be assumed as self-evident, as is commonly done.

about ⅔rds of a mile. These changes will progress (but more and more slowly after attaining a certain maximum rate) for about 23,950 years, when the sun's distance from the centre of the orbit will be reduced to 303,200 miles, and the semi-minor axis will only differ from the semi-major axis by about 500 miles.*

In such minute variations, thus slowly propagated, Laplace found the origin of the secular acceleration of the moon's mean motion. The average effect of the sun's action on the moon is to diminish her gravitation to the earth by one-179th part. The diminution of the earth's influence over the moon *during the month* varies inversely as the cube of the earth's distance from the sun. Now in the development of this inverse cube in a series proceeding according to sines and cosines of the earth's mean motion and its multiples, there is a term $\frac{3}{2} e'^2$ (e' being the eccentricity of the earth's orbit). The diminution of the moon's angular velocity contains the product $\frac{1}{179} \times e'^2$, and this product would be confounded with the mean angular velocity of the moon if e' were constant. But e' is continually decreasing; and the decrease of e' causes a diminished diminution—that is, an acceleration—of the moon's mean angular velocity.

Laplace estimated the acceleration at $10''{\cdot}1816213\ t^2$ (t as before), a result which agreed well with ancient eclipses, though not quite perfectly. When Lagrange applied with the requisite substitutions the formulæ he had already obtained, he arrived at a result almost exactly coincident with that of Laplace. Damoiseau, Plana, and Carlini obtained similar results; the largest estimate of the co-efficient being that of Damoiseau, who made it $10''{\cdot}72$. Hansen obtained the value $11''{\cdot}93$ (in 1842), corrected in 1847 to $11''{\cdot}47$, in 1857 to $12''{\cdot}18$, and recently to $12''{\cdot}557$.

But it was not merely the combination of six of the greatest names in the history of mathematics which seemed to point to this question as settled beyond dispute. A comparison of the results of calculation (when the larger values $11''\,93$, $12''{\cdot}18$, or $12''{\cdot}56$ were used) with the records of ancient eclipses exhibited a correspondence so complete and exact, that no doubt could (or can) exist that the actual acceleration lies between $11''{\cdot}5$ and $13''{\cdot}0$. Six remarkable total or nearly total eclipses of the sun, and nineteen lunar eclipses recorded in the Almagest, are represented so closely by an

* Although the minuteness of the ellipticity of the terrestrial orbit is patent to calculation of the simplest kind, we repeatedly see the variation of this ellipticity cited as a possible cause of the prevalence at long past epochs of tropical or arctic climates in the temperate zones of our earth's surface. It may be readily shown that the greatest possible *decrease* of mean annual temperature due to this cause is less than one-7,000th part of the present mean annual temperature, and the greatest possible *increase* is also quite insignificant. Compare with the above-named difference of one-7,000th the difference of one-15th (460 times larger) between the total amount of heat received in a summer's day, in the northern and southern hemispheres.

acceleration equal to the mean of these values as to leave nothing to be desired. On the other hand, a change of 2″ or 3″ in the assumed value of the acceleration introduces difficulties into the explanation of most of the eclipses, and renders the occurrence of some of them physically impossible.

Despite this accordance, which would have deterred most men from the labour attending the re-investigation of a subject of such difficulty, Adams subjected the problem several years ago to strict and rigid scrutiny. In a memoir read before the Royal Society of London in 1853, he pointed out a cause of disturbance which Laplace and those who had followed him in the calculation of the acceleration had overlooked. We have seen that Laplace had investigated the effect of the central disturbing force only, assuming that the tangential disturbing force would give rise to no permanent alteration of the moon's mean angular velocity; or, in other words, Laplace had assumed that the area described by the moon about the earth in a given time undergoes no permanent alteration. Now, Adams pointed out that when the variability of the eccentricity of the earth's orbit is taken into account, in integrating the differential equations involved in the problem of the lunar motions (in other words, when the eccentricity is made a function of the time), non-periodic or secular terms appear in the expression for the moon's mean motion, and that their effect is to diminish considerably the co-efficient of the lunar acceleration.

In 1856 M. Plana published a paper, in which he expressed his acquiescence with Adams' views, but later he retracted this admission. In 1859 M. Delaunay deduced the same result as Adams, who then published the results of a new investigation, in which he had calculated terms even of the seventh order. The value thus calculated was 5″·7. Three months later M. Delaunay had carried the calculation to terms of the eighth order, and assigned 6″·11 as the value of the co-efficient.

At this stage the views of Adams became the subject of controversy, which for a long time occupied much attention among astronomers. In May, 1859, Pontécoulant entered the field. He objected energetically to the "new terms" developed by Adams, whose processes he characterized as "une véritable supercherie analytique." Hansen pointed out the remarkable coincidence between the value he had obtained and the records of ancient eclipses. Mr. Main examined the question, and came to the conclusion that Adams and Delaunay were in the right, but that Hansen's larger value was needed to satisfy the records of ancient eclipses. Leverrier, on the other hand, declared unreservedly against Adams and Delaunay: "Nous conservons des doutes et plus que des doutes," he said, "sur les formules de M. Delaunay—très-certainement la vérité est du côté de M. Hansen."

But, as Adams had himself remarked, the question was a purely mathematical one. Other methods of investigation were employed; fresh mathematicians entered the lists. Adams himself published two new solutions; Delaunay two more. Professor Donkin examined the problem by a method which had already been applied by Delaunay. Sir John Lubbock applied methods he had before employed in re-calculating other inequalities of the moon's motions. Professor Cayley devised and applied a perfectly new method of investigation. And lastly, Plana, who, as we have seen, had pronounced against Adams, subjected the question to renewed scrutiny. The result of these investigations was to place the correctness of Adams' views beyond dispute, and to assign 6″ as the approximate value of the secular acceleration of the moon's mean motion.

We find ourselves, then, face to face again with the original difficulty. But before considering the solutions which appear to offer themselves, it may be as well to exhibit the minuteness of the inequality which has been the object of discussion, and one-half of which still remains unaccounted for. Assuming 12″ as the actual value of the acceleration, and 6″ as the value of that part for which theory accounts, let us consider the motion of the moon in successive centuries. In the first place, it is necessary to point out the incorrectness of the statement we have seen more than once made, that the moon moves 12″ more in every century than she should do according to theory. That would leave the moon's motion *uniform*. Nor, again, is it correct to say that the moon advances 12″ more in every century than she had advanced in the preceding century. The proper statement of the nature of the acceleration is that the moon advances 12″ *farther* in every century than she would have advanced if she had retained the same mean motion during the century as she had at the *beginning* of that interval. As her mean angular velocity increases uniformly, it is clear that her position at the end of the century is *the same* as she would have had if she had moved throughout the century with the velocity she had in the *middle* of the century, and 12″ *behind* the position she would have had if she had moved with the velocity she has at the *end* of the century. In this last case she would, therefore, have gained 24″; and as she actually does start with this velocity at the beginning of the next century, and further gains 12″ from her acceleration, her total gain is 36″ during the second century. Similarly, it may be shown that in the third century she gains 60″, in the fourth 84″, and so on. Thus in each century she moves 24″ (or about one-78th part of her own breadth) farther than in the previous century. Theory accounts only for half this amount, leaving to astronomers the interpretation of the other half, *that is, of the moon's displacement by about one-156th part of*

her own breadth more in the course of any one century than in the course of the next preceding century!

Adams himself offers no opinion as to the probable cause of the want of accordance between theory and observation which he has thus detected, beyond the remark that "if established the fact would be a most interesting one, and might put us on the traces of an important physical discovery."

It seems little likely that changes in any other element of the terrestrial orbit besides the eccentricity should (as has been suggested) appreciably affect the lunar acceleration. As to the direct action of the planets on the moon we have Euler's opinion that no part of the secular inequality is due to this cause. But it may be worth while to examine this point afresh.

Of the opinion offered by Euler that the acceleration is due to the resistance of an etherial fluid occupying space, Laplace in his earlier dealings with the subject expressed a not unfavourable opinion. But as it appeared that the same cause which produced the secular acceleration affected the motions of the moon's apsidal and nodal lines, and that the proportion existing between these variations corresponded closely with observation, which would not be the case if a resisting medium accelerated the moon's mean angular motion, he considered he had proved that no such medium exists. This proof is now set aside; and the possible effects of a resisting medium have still to be considered. It is hardly necessary to remark that if such a medium exists, the angular velocity of the planets must also undergo a slow process of acceleration. The argument in favour of a resisting medium, derived from the acceleration of Encke's comet, will of course not be overlooked.

Another solution, suggested and examined by Laplace, was that gravity acts progressively, not instantaneously. He showed that in order that such progressive transmission should cause the observed acceleration, its velocity must exceed the velocity of light eight millions of times. To explain that portion of the acceleration for which theory fails to account, the rapidity of transmission of gravity should be yet greater, should in fact be upwards of two thousand billions of miles per second! If, as seems probable, the difficulty can be explained without assuming the progressive transmission of gravity, it would follow of course either that the action of gravity is instantaneous, or that it is so greatly in excess of the last-named velocity that the effects of its progressive transmission are insensible.

In the possible effects of increments accruing to the mass, either of the earth or moon, we have another possible solution of the acceleration, or of a part of it. It is certain that both the earth and moon as they sweep together round the sun, are continually gathering fresh recruits from the bands of meteorites (pocket-planets, as Humboldt has termed them) which revolve in

the interplanetary spaces. It is also certain that any increment thus caused in the mass of either is followed by a decrement (inconceivably minute of course) of the major axis of the lunar orbit, and a consequent increase in the moon's mean angular velocity around the earth.

There remains only to be considered the question of a possible retardation of the earth's motion of rotation. This solution of the difficulty was discussed by Laplace.* The only cause assigned in his time for such a retardation was the influence of the trade-winds upon the great mountain chains. He showed that this cause was insufficient to affect appreciably the earth's period of rotation. And further, as his calculations appeared to afford a complete explanation of the lunar acceleration, he felt himself justified in pronouncing his famous dictum on the constancy of the sidereal day. Of course, now that this accordance between theory and observation has been shown not to exist, the question is reopened. A cause of retardation not considered by Laplace has also been suggested, Mayer having pointed out (in 1848) that the tides "do work" on the earth, and that this work is the equivalent of a certain amount of "*vis viva*" lost in the earth's motion of rotation. M. Delaunay has now shown that this cause would probably be sufficient to account for the acceleration of 6″ in a century.

Assuming this explanation to be the true one, it appears that our great terrestrial time-piece, hitherto supposed to be keeping most perfect time, requires *correcting* and *rating*. In the course of the last 2,000 years it has lost nearly an hour and a quarter, and compared with its motion at the beginning of that interval, it is now losing one second in twelve weeks. The day is also lengthening, and will continue to do so until it is equal in length to the lunar day, that is, to our lunar month. The inhabitants of earth may console themselves, however; for the rate of change will diminish continually, and even if it did not, thirty-six billions of years would have to elapse before the change would be fully effected.

But although the races at present inhabiting the earth are not likely to be affected, either for good or evil, by the process of change we have been considering, it is impossible not to look with interest into the vista of the far future, and trace our earth in its gradual progress to the condition now presented by the moon,—to its degradation, may we not surmise, from the position it now holds as a life-sustainer. Looking backward into the far past, we see a progress of a like nature through which our moon has passed while the earth's strong influence has been exerted on her rotation,

* The explanation is suggested parenthetically by Newton in the second edition of the 'Principia:' "Halleius noster motum medium Lunæ *cum motu diurno terræ collatum* paulatim accelerari primus omnium quod sciam deprehendit."

coercing it down to correspondence with her revolution. We see her subjected, meanwhile, to other changes not less destructive. The bloom of life has long since passed from her face. Who shall say that our own beautiful earth will not one day resemble her?

Our great terrestrial time-piece being *slow*, actually and also rateably, it follows that all astronomical phenomena referred to any fixed past epoch, apparently occur too soon, just as they would do if timed by a "slow" clock in an ordinary observatory. In each century, for instance, the sun's apparent annual motion is accelerated by about 0″·4, the heliocentric motion of Venus by about 0″·7, and that of Mercury by about 1″·7. After long intervals of time such changes must become appreciable. We have here, then, a test which future ages will be able to apply to the explanation offered by Delaunay.

In whatever way the discrepancy detected by Prof. Adams may eventually be explained, no doubt can exist of the importance of the discovery. It may rank worthily with the noblest labours of Clairant and Euler, Lagrange and Laplace, Airy, Hansen, and Leverrier. One achievement alone since Newton's discovery of gravitation seems to claim a higher estimate,—in that achievement Adams shares equal honours with the illustrious Frenchman, Leverrier.

THE BRITISH ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE.

MEETING AT NOTTINGHAM, AUGUST, 1866.

THE annual gathering of British philosophers may be regarded from a twofold point of view. By some it is looked forward to as a meeting where scientific papers of special interest are read and discussed, whilst by others it is treated as a holiday. To the former class the sections gave ample gratification, whilst to the other and more numerous class, including as it does the majority of the eminent scientific men present, who naturally embrace this opportunity of enjoying a holiday in company with friends of their own intellectual calibre, the numerous excursions which were arranged to different places of interest in the neighbourhood, afforded an agreeable relaxation from the scientific labours, which they visited Nottingham to get relief from, rather than to augment.

Writing after the close of the meeting we may pronounce it a moderately successful one; the numbers present having been 2,221, being about 200 more than at Birmingham, 580 less than at Bath, and 1,100 less than at Newcastle. There is no doubt that much, if not all of this falling off, is due to the most exorbitant price which was demanded for lodgings. Long before the meeting, scientific men were startled at being asked nearly seven times as much as they had been in the habit of paying for similar accommodation at Birmingham, Bath, or Newcastle, and during the meeting complaints of extortion were repeatedly heard in the reception-room. In many cases as much was asked to lodge a family for the time of the meeting as would pay the rent of the house for the year, and the result has been that a great number of scientific men who had intended going were frightened by the demands and went elsewhere, whilst not more than a fraction of the lodgings put down on the official list were tenanted. It is to be hoped that at future meetings of the Association this point will be properly attended to, and that the vital subject of lodging accommodation for the guests invited to a town be not left entirely to the discretion of a chairman and committee of the inhabitants, whose chief work in the present instance appears to have been to fix a prohibitory tax upon the letting of the apartments. We are very confident that had the deputation, which attended last year at Birmingham for the purpose of inviting the Association to meet at Nottingham, told the general meeting that it was their intention to fix the price of decent

apartments for a family at about five times that ordinarily charged at a good hotel, their hospitable invitation would have been courteously declined. This is a subject which ought to be definitely mentioned in all future invitations, so that members may not again be asked 18*l.* for the same accommodation which cost about 55*s.* at Newcastle, Bath, and Birmingham. As a set-off against the rapacity of the lodging-house keepers, it deserves prominent mention that the private hospitality at Nottingham has been of a character unprecedented in the annals of the Association. Upwards of 500 houses in the town were opened for the reception, as guests, of visitors who before the meeting were totally unknown to their hosts, but who now retain a grateful recollection of their boundless hospitality and courteous generosity.

The General Committee met for the first time on Wednesday, the 22nd of August, when the several Reports of the Council, the Treasurer, the Kew Committee, and the Parliamentary Committee were read.

In the evening a crowded audience assembled in the theatre to listen to the Address of William Robert Grove, Esq., Q.C., M.A., F.R.S., President of the British Association.

The President's Address.

After a graceful allusion to the progress which had been made by Nottingham in the application of machinery, almost resembling organic beings in delicacy of structure, by which products of world-wide reputation were fabricated, the President proceeded to draw comparison between the British Association and other learned bodies. Apart from the novelty and freshness of an Annual Meeting, the great advantage resulting from the visits of this great Parliament to new localities was, that while it imparted fresh local knowledge to the visitors, it left behind stimulating memories. The tardy recognition of Science by the Government, and the ignorance of elementary scientific truths among so-called well-educated men, were eloquently alluded to, and the hope was expressed that the slight infiltration of scientific studies, now happily commenced in our Universities, our public and private schools, would extend till it occupied its fair space in the education of the young, and that those who might be able learnedly to discourse on the Eolic digamma would not be ashamed of knowing the principles of an air-pump, an electrical machine, or a telescope. Referring to the recognition of Science by the Government, the Report of the Kew Committee for this year afforded a subject of congratulation. The Kew Observatory might possibly become an important national establishment, and if so, while it would not lose its character of a home of untrammelled physical research, it would have superadded

the Meteorological Department of the Board of Trade, with a staff of skilful and experienced observers.

The President then submitted to his audience certain views of what has within a comparatively recent period been accomplished by Science, what have been the steps leading to the attained result, and what, as far as we may fairly form an opinion, is the general character pervading modern discovery. One word gave the key to the discourse; that word was *continuity;* no new word, and used in no new sense, but perhaps applied more generally than it had hitherto been. The speaker proceeded to show that the development of observational, experimental, and even deductive knowledge was either attained by steps so extremely small as to form really a continuous ascent; or when distinct results apparently separate from any co-ordinate phenomena had been attained, that then, by the subsequent progress of Science, intermediate links had been discovered, uniting the apparently segregated instances with other more familiar phenomena.

This view was applied to the recent progress of some of the more prominent branches of science. In astronomy, the discoveries in gravitation as affecting double stars; the apparent exception to its influence in the case of some of the nebulæ; the recent researches on meteorites; the observations on the intra-mercurial planets; the identity in chemical composition between meteorites and terrestrial minerals; and their specific gravity as compared with that of the earth, were all adduced as affording proof of *continuity* pervading the universe. Optics likewise gave evidence in the same direction. The discoveries by spectrum analysis, and especially those of Mr. Huggins, on cometary, nebular, and stellar spectra, and especially of the temporary star which shone forth this year, and the deductions arising therefrom, were alluded to. The physical constitution of the Moon's surface, and the granular character of that of the Sun, were finally noticed in the astronomical review.

Magnetism and the conservation of force (in illustration of which a forgotten experiment, shown by the speaker a quarter of a century ago at the London Institution, was recalled), and the consequence resulting from the dynamical theory of heat in the retardation of the earth's rotation, were rapidly referred to. The exhaustion of our available force stored up in coal, and the latest discoveries of Professor Graham, as affording us indications of means of storing up force, were next glanced at, although the speaker said that at a time when science and civilization could not prevent large tracts of country being irrigated by human blood, in order to gratify the ambition of a few restless men, it seemed an over-refined sensibility to occupy ourselves with providing means

for our descendants in the tenth generation to warm their dwellings or propel their locomotives.

The two very remarkable applications of the convertibility of force, attained by the experiments of Mr. Wilde and Mr. Holz, promised results of extended application, and were aptly described as showing how, by a mere formal disposition of matter, one force could be converted into another; and that not to the limited extent hitherto attained, but to an extent co-ordinate, or nearly so, with the increased actual force, so that, by a mere change in the arrangement of apparatus, a means of absorbing and again eliminating in a new form a given force might be obtained to an indefinite extent. As we may, in a not very distant future, need, for the daily uses of mankind, heat, light, and mechanical force, and find our present resources exhausted, the more we can invent new modes of conversion of forces, the more prospect we have of practically supplying such want.

Rapidly glancing at the considerable strides which were being made in physiology, by studying the relation of organized bodies to external forces, the speaker passed on to the facts recently brought to light by geological inquiries, which, while on the one hand they afforded striking evidence of continuity, on the other, by the breaks in the record, might be used as arguments against it; and supposing that the geological formation was of a continuous character, there came the question whether the different characters of the fossils represented absolute permanent varieties, or might be explained by gradual modifying changes.

The subject to which the President devoted most attention was the always popular one of the origin of species, and the question whether, what we term species, are and have been rigidly limited, and have at numerous periods been created complete and unchangeable; or whether, in some mode or other, they have not gradually and indefinitely varied; and whether the changes due to the influence of surrounding circumstances, to efforts to accommodate themselves to surrounding changes, to what is called natural selection, or to the necessity of yielding to superior force in the struggle for existence, as maintained by our illustrious countryman, Darwin, have not so modified organisms as to enable them to exist under changed conditions. The difficulty of producing intermediate offspring from what are termed distinct species, and the infecundity in many instances of hybrids, have been used as strong arguments against continuity of succession; on the other hand, it might be said that long-continued variation through countless generations had given rise to such differences of physical character, that reproduction was difficult in some cases, and in others impossible. In favour of this latter view the following illustration was adduced: Suppose M to represent a parent race, whose offspring, by successive changes

through eons of time have divaricated, and produced on the one hand a species A, and on the other a species Z; the changes here have been so great that we should never expect directly to reproduce an intermediate between A and Z. A and B on the one hand, and Y and Z on the other, might reproduce; but to regain the original type, M, we must not only retrocede through all the intermediates, but must have similar circumstances recalled in an inverse order at each phase of retrogression—conditions which it is obviously impossible to fulfil. But there was another difficulty in the way of tracing a given organism to its parent form, which from our conventional mode of tracing genealogies, was never looked upon in its proper light. This was well illustrated by the speaker: Where were we to look, said he, for the remote ancestor of a given form? Each of us, supposing none of our progenitors to have intermarried with relatives, would have had, at or about the period of the Norman Conquest, upwards of a hundred million direct ancestors of that generation. Let anyone assume that one of his ancestors at that time was a Moor, another a Celt, a third a Laplander, and that these three were preserved while all the others were lost, he would never recognize either of them as his ancestor, he would only have the one-hundred-millionth of the blood of each of them, and as far as they were concerned there would be no perceptible sign of identity of race. From the long-continued conventional habit of tracing pedigrees through the male ancestor, we forgot, in talking of progenitors, that each individual had a mother as well as a father; and there was no reason to suppose that he had in him less of the blood of the one than of the other.

In indicating a few of the broad arguments on this subject, the speaker explained, that if he appeared to lean to the view that the successive changes in organic beings did not take place by sudden leaps, it was from no want of an impartial feeling; but if the facts were stronger in favour of one theory than another, it would be an affectation of impartiality to make the balance appear equipoised. Perhaps the most convincing argument in favour of continuity, which could be presented to a doubting mind, would be the difficulty it would feel in representing to itself any *per saltum* act of nature. We were forced by experience, though often unconsciously, to believe in continuity as to all effects now taking place, and the fair question was, Did the newly-proposed view remove more difficulties, require fewer assumptions, and present more consistency with observed facts than that which it sought to supersede? If so, the philosopher would adopt it, and the world would follow the philosopher—after many days.

In summing up this part of the argument, the speaker concluded by saying, that if we were satisfied that continuity was a law of nature, the true expression of the action of Almighty Power, then, though

we might humbly confess our inability to explain why matter was impressed with this gradual tendency to structural formation, we should cease to look for special interventions of creative power in changes which were difficult to understand, because, being removed from us in time, their concomitants were lost; we should endeavour from the relicts to evoke their history, and when we found a gap not try to bridge it over with a miracle.

PHYSICAL SCIENCE. (Section A.)

The proceedings of this Section commenced on Thursday, August 23rd. In giving notices of the papers read, we shall adopt the plan followed on previous occasions, and confine our remarks to those subjects only which are likely to be new to our readers, and appear to be of general interest.

The first paper was a report on luminous meteors, read by Mr. Glaisher. In this report the Committee showed a marked degree of progress over their success in previous years. Not only have observations of three large meteors at the Royal Observatory, Greenwich, been confirmed by descriptions of observers at different places, so that the height and velocity of the meteors could be calculated; but the accounts sent by different observers has in several other instances led to the same satisfactory result. The radiant indicated by the charts of the meteoric shower of November last, is situated within two degrees of the place which it occupied during the interval of greatest meteoric activity in the year 1833. The heights of the November meteors is shown in this report to be the same as that of ordinary shooting stars, or sixty miles above the surface of the earth.

A strong probability exists of the occurrence, on the morning of the 13th of November next, of a more extraordinary meteoric shower than any that has yet been observed at the English Observatories, and the occasion of the return of the great November shower being one of very rare occurrence, the Committee have provided themselves with two spectroscopes specially adapted for analyzing the light of shooting stars. The average velocity of eleven meteors directed from Leo is $55\frac{1}{2}$ English miles per second. The average velocity of four meteors directed from Taurus or Perseus is 19 miles per second. As the former radiant region is hardly 20° and the latter more than 100° removed from the apex of the earth's way, it follows that the earth's motion of translation is plainly recognized by its effect of increasing the speed of the meteors from the former, and diminishing the speed of the meteors from the latter radiant point. Some observations on the spectra of meteors made at Hawkhurst by Mr. Herschel, are very interesting.

In one instance the appearance of a meteor in the spectroscope was unaltered, being that of an ordinary yellow shooting-star, leaving a yellow streak upon its course; and when the spectrum of the meteoric streak was diffused, a bright yellow very slender line was frequently observed in the spectrum on the side towards the red. The presence of the bright yellow line in a very conspicuous form in many of the streaks, points to the conclusion that sodium is frequently present.

Mr. Birt then read the report of the lunar committee for mapping the surface of the moon, from which it appeared that maps had been drawn on a scale of 100 inches for the diameter of the moon, some part of which had been enlarged to 400 inches, and a number of observations catalogued, which exceeded anything previously attempted. Mr. Browning gave a description of some recent improvements in astronomical telescopes with silvered glass specula, in which he described an improved method of mounting the speculum.

After a paper by Dr. Gladstone and Rev. T. P. Dale on dispersion equivalents, Mr. J. P. Harrison read a paper on the heat attained by the moon under solar radiation, from which it would appear that on the 22nd day of lunation, seven days after full moon, the temperature of the moon would be 840° F., a temperature of about dull redness, and exceeding the fusing point of tin and lead.

Amongst the papers read the next day was one by Mr. Hooper, on the electrical and mechanical properties of Hooper's India-rubber for submarine cables. He reduces the general coatings of India-rubber by means of heat to one perfectly homogeneous coating, separated by a film of vulcanized India-rubber, the advantages claimed are durability and resistance to mechanical injury, permanency of insulation at high temperatures, impermeability under long immersion and pressure in water, freedom from defects in manufacture, and high state of insulation with diminished induction. One hundred and fifty miles of this wire have been sent to India, and the insulation per nautical mile is about forty times better than that of the Persian Gulf core.

Professor Jellett then gave a paper on a fluid possessing the power of rotating the planes of polarization of rays, of the opposite ends of the spectrum in opposite directions; and Mr. Hind afterwards made some remarks on the recent extraordinary outburst of the variable star in Corona, from which it would appear that the change in the star did not take place with such astonishing suddenness as had been generally assumed. If such were the case, it destroyed the romance of its being a world in conflagration.

The next day was devoted to abstract mathematics. On Monday, Mr. Claudet described a new process for producing harmonious and artistic photographic portraits. One of the greatest deficiencies of photography is the impossibility of obtaining a well-defined image of all the various parts situated in different planes. The object of the author has been to discover a method of removing, if possible, from photographic portraiture that mechanical harshness which is due to the action of the most perfect lenses. The author effects this by gradually moving one of the lenses while the person is sitting, so that all parts of the image shall come successively *in* and *out of* focus, during one part of the exposure, and all in the same degree. By this simple contrivance, Mr. Claudet has succeeded in taking a photographic portrait without hard lines, but with the lights and shades blended in the most artistic harmony.

An elaborate paper followed on the North Atlantic Telegraph, by Mr. Holmes. After alluding to the various attempts which had been made to establish electrical communication between Europe and America, and the success with which they had been ultimately crowned, the speaker said that long unbroken lines of submarine cables were placed at a very great disadvantage in their transmitting power as compared with land lines; the retardation (or slowness of transmission of the currents) that takes place from the law of induction forming one very serious cause of interference. The constant flow of induced earth currents through the wire, variable both in their intensity and direction, is another disadvantage to the employment of long unbroken lines of submarine cables. In the words of Professor Wheatstone, the impediments to the rapid succession of signals have been proved to be in proportion to the length of the conductor. The project advocated by Mr. Holmes is a line of telegraphic communication between England and America, which is to be immediately carried into effect, *via* Scotland, the Faroe Islands, Iceland, Greenland, and the coast of Labrador, and known as the North Atlantic Telegraph. A glance at the map in the direction pointed out will at once show that convenient natural landing stations exist, breaking up the cable into four short lengths or sections, instead of the necessitous employment of one continuous length, as between Ireland and Newfoundland. It will also be found that the aggregate length of these sections is within a very few miles the same as that of the Anglo-American Cable. Not only will this subdivision of the cable reduce mechanical risks in submerging, but what is of far more importance, the retardation offered to the passage of the current through the several short sections is almost as nothing when compared with the unbroken length of two thousand miles. As regards the danger from icebergs, the depth of the soundings up the Julianshaabfjiord, where

the shore end of the cable in Greenland is to be laid, indicate its security from ice when submerged. The landing places of the cable in Iceland are likewise in no way liable to be disturbed by ice of such a nature as to cause damage to the cable. In the discussion which followed, Mr. Holmes stated that the relay stations would probably be mechanical, and not subject in any way to the human hand. Mr. Varley, referring to earth currents, was happy to inform the meeting that, although the earth currents in the present Atlantic Cable were decidedly strong, the speed of transmission was not retarded in the slightest degree. Captain Maury objected to the present system of making deep-sea cables, as rendering them unnecessarily heavy. Mr. Holmes, in reply to Captain Maury, said that he thought he might go so far as to say that in the deep-sea sections of the cable no iron would be used.

Mr. Varley afterwards read a paper on certain phenomena which presented themselves in connection with the Atlantic Cable. These had reference almost entirely to certain phenomena of what he termed magneto-electric momentum, which were observed while testing the cable on board the Great Eastern, and also at Valentia after it was laid. The results, which were of the highest theoretical interest, will unfortunately not bear condensation.

In the Report of the Committee on the Transmission of Sound through water, it was stated that the rapid extinction of musical sounds in water rendered it almost hopeless to employ them for communicating signals in that medium, whilst an iron bar struck longitudinally could be heard at a very great distance. The Committee are continuing their observations on the possibility of using these sounds as fog signals.

A contribution by Mr. Evan Hopkins, "On the Depolarization of Iron Ships," was read. In this the author states that he has destroyed, or even reversed, in a few hours the polarization of vessels by means of electro-magnetic batteries. In order to test the practicability of this system upon a ship of the largest size and containing an enormous mass of iron, the ship 'Northumberland' was submitted to this plan, and on the 4th of August it was depolarized head and stern in a few hours by means of two Grove's batteries of five cells each and electro-magnets.

W. C.

Chemical Science. (Section B.)

The proceedings of this Section were opened by Dr. H. Bence Jones, F.R.S., with an address, in which he specially referred to the relations of Medical and Chemical Science and the present system of Medical and Scientific Education. In the medical profession the early

years of study, those in which the mind is most capable of acquiring knowledge, are spent in great measure in learning Latin, Greek, Mathematics, or Divinity, and perhaps some modern language; and it is not till the age of twenty is past that one single step is taken towards the object required, and then the student is expected to compress the acquirement of Physics, Chemistry, Botany, Anatomy, Physiology, and the practice of Medicine, Surgery, and Midwifery, into the inadequate space of three years. What chance has a medical man of understanding the action of the chemical, mechanical, and electrical forces in the body, until a fundamental knowledge of chemistry, mechanics, and electricity has been first obtained?

The result is that chemists of the higher class, who have been hampered in their scientific education by no obsolete rules and traditions, are rapidly encroaching on the domain of the medical man. They not only understand fully the nature and uses of food and medicines, but they are becoming able to detect the first appearance of a multitude of chemical diseases. Their habits of investigation and their knowledge of the nature of the forces acting in the body are gradually leading them to become advisers in all questions regarding the health of the community. Intending to demonstrate this part of his argument by reference to a recent event, Dr. Bence Jones made the following remark:—"In confirmation of my opinion of the direction in which the treatment of disease is progressing, I may just refer to the cattle plague, which in 1745 was treated by Dr. Mortimer, at that time Secretary of the Royal Society, and therefore one of the most scientific physicians in the country, with antimony and bleeding. In 1866, two chemists (Dr. Angus Smith, Ph.D., F.R.S., and Mr. Crookes, F.R.S.) gave the only useful suggestions for combating the disease, namely, by the arrest or the destruction of the poison by chemical agents."

The first paper read was a preliminary report on the chemical nature of cast-iron, by Dr. Matthiesson. In it the author principally confined himself to an outline of the investigation which he proposed to make: an account of the results being deferred till next year.

Mr. Weldon read a paper on a new process for the manufacture of Soda, by the use of fluorine. The details were somewhat complicated and involving numerous chemical transformations. The result was said to produce soda without the consumption of anything except salt and coal. One great advantage of this process appears to be that the soda is yielded in the caustic state and not as carbonate. If successful on the large scale this will be a very important chemical discovery, and the profits of it millions.

After a paper by Dr. Attfield on the assay of coal for crude

paraffin oil, and of crude oil and petroleum for spirit, photogen, lubricating oil, and paraffin, Dr. Stevenson-Macadam gave an account of some experiments in which he had been engaged on the poisonous nature of crude paraffin oil and the products of its rectification. His attention had been drawn to the subject on account of the great mortality which had taken place among the fish in some Scottish streams, and the experiments fully proved that the destruction had been caused by the discharges from paraffin oil works.

Dr. Daubeny opened the meeting the next morning with a paper on Ozone. His researches tended to show that the atmospheric ozone was almost entirely due to plants, the green parts of which generate ozone, whilst they emit oxygen. The flowers generate no ozone.

Mr. Spence then described a new and probably important process for manufacturing white lead. It consists briefly in dissolving oxide of lead (from poor lead ores) in caustic alkali, and then precipitating by carbonic acid. The process was illustrated before the meeting.

Mr. Crookes then read some notes on Disinfection, principally in reference to the present outbreak of cholera in London. He gave several examples of the ignorance and waste characterizing the employment of disinfectants in different parts of London, and pointed out the absurdity of using at the same time, in the various parishes of London, disinfectants that were incompatible with one another. In one parish strong oxidizing disinfectants were largely used, in the adjoining one powerful deoxidizing disinfectants were employed; so that when the streams of sewage met from the different districts, the several agents exerted reciprocally an antagonistic action, thus expending their energies in mutual destruction, instead of uniting them in serviceable work. It was shown that oxidizing disinfectants were quite inadequate to cope with an evil of any great magnitude, but that antiseptics could be fully relied upon.

The principal paper of general interest the next day was one by Mr. Larkin, on the Magnesium Lamp. The distinguishing peculiarity of these lamps is that they burn magnesium in the form of powder instead of ribbon or wire. The metallic powder, mixed with sand as a diluent, is contained in a large reservoir, from which it flows through a tube at the bottom. Upon reaching the orifice, the metallic powder ignites, and burns with a brilliant flame. A small jet of gas issuing from the same orifice affords a permanent means of ignition, and the flow is regulated or shut off by a valve. At the first soirée in the Mechanics' Hall, where these lamps were exhibited, some complaint arose on the part of the ladies present,

owing to the ghastly effect the light of the burning magnesium produced on their complexions. At the second soirée this fault was obviated in an ingenious way, by the addition of a little nitrate of strontia to the metallic powder, the result being to communicate a warm roseate hue to the light, and entirely to remove the unpleasant effect previously noticed.

W. C.

Geology. (Section C.)

Though in this Section there were, perhaps, scarcely so many as usual of those commonly regarded as the leaders of geological opinion, a considerable number of eminent and diligent geologists were in attendance, and took an active part in the proceedings.

In his inaugural address, the President of the Association stated that most geologists of the present day, instead of holding that the breaks or chasms in the geological record represent sudden changes in the formation of the earth's crust, adopt the alternatives that they arise from dislocations occasioned since the original deposition of strata, or from gradual shifting of the areas of submergence; that the advance of science has more or less filled up the gaps supposed to exist between the characteristics of the extinct and the new species; and that the apparent difficulty of admitting unlimited modification of species would seem to have arisen from the comparison of the extreme ends of the scale, where the intermediate links or some of them were wanting.

In these statements the President struck the key-note of the proceedings of the Geological Section during the following week. Never, probably, did the authors of papers, or those who took part in the discussions which they elicited, appeal so little to convulsion, cataclysm, or catastrophe. Professor Ramsay, in the address with which, as its President, he opened the Section, echoed back the sentiments which his Chief expressed on the previous evening. Having described the contortions of mountain chains and, in fact, the disturbance of strata generally, especially those which occur in North Wales, Scotland, the Alps, and Cumberland, he remarked, "Respecting the agencies to which these changes are due, one opinion is that we now live in a world, as nearly as can be in a finished state, which has to suffer no more catastrophes; another, that we are now remaining in a temporary state after a succession of spasms, but that they may recur again at some period a long way before us; or, again, that the state of tranquillity we now enjoy has been the seeming order in all time, as far as geologists can trace back the action of the processes which have brought us to the present condition of the world. These are the three leading opinions, and my own inclines to the last." Having discussed the connection of

life with the modifications which have taken place in the crust of the earth, he summed up by observing that "the great principle remains of a succession of life which shows a method of progress—the old disappearing and the new coming in; that the breaks in continuity have a close connection with unconformability of strata; that there never has been universally over the world any complete destruction of life; that the succession of existences has gone on in regular order and sequence; but that we have lost a great number of the records—whole chapters, whole books—by the immense disturbances in the earth's crust. Putting all things together, we are pointed to the conclusion that all these changes have been so slow and gradual, that to the occupants of the old time, if they had had reason to observe, everything would seem to go on in the same slow, steady, and apparently undisturbed manner in which they appear to us to go on now; and if this be true, instead of having recourse to unusual catastrophic action to explain what is seen to have resulted, it all resolves itself into the process of time,—the effect produced in long spaces of time by small causes which were accumulative, and so were more than equal to all the unusual destructive forces which were attributed to the igneous rocks, which latter, with all other rocks, yielded to those causes which have brought about the astonishing changes which the world has so visibly undergone, resulting in the present physical geology and geography of the earth's surface."

Though the number of papers sent in was smaller than that of several immediately preceding years, and though none of them contained an announcement so revolutionary as that made at the Bath Meeting of the discovery of organic remains in the "Azoic" rocks, the supply was so large as to render it necessary for the Section to sit more than once long beyond the prescribed hour, and the quality betokened steady and general progress and occasionally drew an audience sufficient to fill the very large room in which the Section was located.

Mons. Pierre de Tchihatchef, a distinguished Russian traveller, gave in excellent English an interesting account of "Eight Years' Researches in Asia Minor," where, entirely at his own expense, he had journeyed over 21,000 miles, and had occupied himself in various branches of scientific research, especially geology and botany.

In their "Second Report on the Geology of St. David's, Pembrokeshire," Messrs. Hicks and Salter stated that the rocks of the district are divisible, in ascending order, into the Harlech, Menevian, Ffestiniog, Tremadoc, and Arenig or Skiddaw groups, the whole being crowned with the Llandeilo beds; that about 65 or 70 new species of animals had been found, peculiar to the district; that the Harlech or lowest group have a passage downwards into the central

syenitic mass, so distinct and gradual as to induce the belief that that mass is throughout no other than altered Cambrian; and that the Menevian is the great fossiliferous group, containing more than 40 species, including 3 species of *Paradoxides*, which are never found together.

Mr. Nicholson, in his paper "On Fossils from the Graptolite Shales of Dumfriesshire," stated that in the shales near Moffat, long known to yield graptolites, he had detected numerous bodies which, in their most perfect condition, were bell-shaped, averaged three-tenths of an inch in length and two-tenths in breadth, and were provided at one extremity with a prominent spire, the other terminating in a nearly straight or gently curved outline, and presenting, somewhere within their margin, an elevated point surrounded by several concentric ridges disposed with more or less regularity. In most cases the bodies were free and independent, but they occasionally occurred in such close juxtaposition to *Graptolites Sedgwickii* as to justify the belief that they were ovarian vesicles, at first attached to the parent stem, but finally becoming swimming zooids. If this conjecture were correct, the *Graptolitidæ* would have to be referred to the *Hydrozoa*, and would find their nearest living analogues in the *Sertularidæ*.

In a paper "On a peculiar Denudation of a Coal Seam in Coate's Park Colliery," Mr. Oakes expressed the opinion that the observed phenomena distinctly proved the existence of an ancient, gigantic, rapid river, the bed of which is now 160 yards below the surface.

As might have been anticipated, Sir R. I. Murchison's paper, "On the Various Tracts of England and Wales in which no Productive Beds of Coal can reasonably be looked for," attracted a very large audience. The author, having described so much of the geology of Britain and France as bore on his subject, and having pointed out the bearings of the facts which he brought forward, thus concluded his discourse: "By excluding from the inquiry into the present or probable future coal supply of England and Wales all the tracts of crystalline and Palæozoic rocks which rise out from beneath the carboniferous strata, and in which no trace of coal can ever be discovered, and also all those secondary and tertiary rocks beneath which it is hopeless to look for coal, it will be seen that the existing and possibly future supplies have, for all practical purposes, an approximately defined limit, and that they range over little more than one-eighth of England and Wales, or an area of about 6,000 square miles. I fully appreciate the anxious desire which is felt by all those persons who are interested in the future welfare of their country, to have the subject fully and fairly inquired into; the more so as I have now, in conclusion, to announce that by the last inquiry made by Mr. Robert Hunt, the last year's con-

sumption of coal reached the portentous figure of nearly one hundred millions of tons. I have simply endeavoured in this communication to indicate to the public that they are not to believe in the almost boundless range of our coal fields which some persons would assign to them."

From Mr. Hedley's communication "On the Sinking of Annesley Colliery," about eleven miles from Nottingham, it appears that the shaft is at present 200 yards deep; that the formations through which it passes are New Red Sandstone, 68 feet; Permian, about 150 feet; below which are the usual alternations of sandstones, shales, thin coals, and fire clays of the Coal measures, which dip due east, about 1 in 36, conformably with the Permian beds; that when about six feet above it, water burst up from the Magnesian limestone in such abundance that the three pumps which were constantly employed discharged 1,500 gallons per minute; and that as the sinking progressed it was necessary to line the shafts with cast-iron tubing to the depth of 98 yards, below which ordinary brickwork sufficed. The author regarded this sinking as affording conclusive proof of the practicability of sinking through the water-bearing strata which cover a large area of Coal measures in the eastern part of Nottinghamshire.

Professor Hitchcock, of Lafayette College, United States of America, stated, in his paper "On the Geological Distribution of Petroleum in North America," that the petroleum produce of the United States increased from 24 millions of gallons in 1862, to upwards of 91 millions in 1865; the value of the latter quantity being about four million pounds sterling. Petroleum sometimes occurs in synclinal basins, in cavities and fissures in the strata which may or may not lie in synclinal basins, in long lines of faults, and beneath anticlinal arches. Great wells involve three essentials:—Plenty of bituminous matter in the petroleum formation, from which an abundant supply may be drawn; cavities and crevices formed by the unequal elevation of the strata; an impervious cover, like the roof of an anticlinal, to have prevented the escape of the petroleum gas in past ages. In the American continent, an area several hundred thousand square miles in extent is underlaid by oleiferous formations, which are known to have a vertical range from the Pliocene, through the Cretaceous, Triassic, Carboniferous, and Devonian, to the Upper and Lower Silurian. The quantity and quality of the petroleum is proportional to the depth to which the wells descend. The lightest oils come from the greatest depths. In conclusion, the author asked, and commended to the attention of the Association, the question, which he confessed himself unable to answer, "How was the petroleum formed?"

Kindred to the foregoing was Professor Ansted's paper "On

Intermittent Discharges of Petroleum and large Deposits of Bitumen in the Valley of Pescara," which runs up from the Adriatic to a narrow and important gorge of the Apennines, about 35 miles from the sea. Near the gorge the rocks are limestones overlying chalk. The former are cavernous, and bitumen exudes freely in summer from the exposed surfaces wherever there are cracks. A couple of miles from the valley to the south there are water-courses down which much water rushes after rain. There are many swallow holes into which water enters, and from openings in the rocks below large bodies of water sometimes issue. From one of these, when rain has fallen, the water comes out mixed with petroleum. The author saw about 1,500 gallons collected in two days, or 1,000 gallons of available petroleum, yielding valuable light and heavy oils and asphalte on distillation. At Letto, about half way towards the coast, and within an area of five miles' radius, are enormous deposits of bitumen and much sulphur. At Letto itself there is a vast gorge filled up with little else than a dyke of earthy and some very pure varieties of black and brown bitumen, which the author traced 1,600 yards. On the north wall of the dyke was an enormous deposit of native sulphur in crystals.

In a second communication, the same author gave an account of a "Mud Volcano close to the South-western Extremity of the Lavas on the Flanks of Etna," about 600 feet above the sea, and which was in a state of eruption in January last. It commenced by the outburst of a strong jet of muddy water, which rose about six feet, at a boiling temperature. Several such jets followed from other places a few yards off. The temperature diminished slowly from the commencement. There was neither noise, flame, visible vapour, stones, nor lumps of solid matter, but much gas bubbling through the water, and some naphtha. The gas was chiefly carbonic acid, which, in large bubbles, issued by puffs of about 40 per minute. A multitude of smaller jets came out from cracks in the ground at various points within an area of about twenty acres.

Mr. H. Woodward, in his "Second Report of the Fossil Crustacea," described a new species of the genus *Æger* from the Lias of Charmouth; a new genus of Phyllopodous Crustacea from the Lower Silurian Shales of Dumfriesshire; the oldest known British Crab, from the Forest Marble of Malmesbury, Wilts; and six species of the genus *Eryon*—five from the Lias, and one from the lithographic stone of Solenhofen. The author stated that having lately had the opportunity to examine specimens of *Limuli* from the Coal Measures, he was enabled to demonstrate the connection between this division of Crustacea and the more ancient *Eurypteridæ* on the one hand, and the recent King-crabs on the other.

Mr. Burton's paper on "The Occurrence of Rhætic Beds, &c.,

near Gainsborough" established the identification of the deposits in question with the Rhætic beds of the Continent, and thus gave to this formation an extension northwards beyond that it had been previously known to possess.

Mr. Seeley, in illustration of his communication on "The Character of Dolichosaurus, a Lizard-like Serpent of the Chalk," submitted to the Section a beautiful specimen of the fossil. His general conclusion was that it was a new type of creature between the serpent and the lizard.

In Mr. Walker's paper on "The Lower Green Sand of Bedfordshire," some account was given of the occurrence of phosphatic nodules in a conglomerate supposed to represent both the Gault and the Shanklin Sands, and which occurs near Sandy.

From Mr. Mitchell's "Report on the Alum Bay Leaf-bed," it appears that this bed is the band of white clay occurring in the Lower Bagshot beds in Alum Bay. It is about six feet thick, but one portion only, a few inches in thickness, contains the plant remains. No other fossils have been noticed. When first exhumed, the outlines and even the most delicate venation of the leaves are clearly visible; but a few hours' exposure to the air obliterates the more delicate marks. About 470 specimens have been obtained.

Closely related to the subject of this paper was that by the Rev. Professor Heer, "On the Miocene Flora of North Greenland." Different voyagers have, from time to time, brought from Greenland, and lodged in various museums in Britain and Ireland, rich collections of fossil plants, all of which have been submitted to Dr. Heer. They were all found 1,080 feet above the sea, on a steep hill, at Atanekerdluk, opposite the Isle of Disco, in lat. 70° N. A total of 66 species have been recognized, and from them and their associated facts, the author infers that they must have grown where they were found; that they belonged to a Miocene flora rich in species, at least some of which extended to still higher latitudes; that in the Miocene epoch the climate of North Greenland was warmer then it is at present by fully 16° C., or 28·8° F.; and he thinks that "we could not by any re-arrangement of land and water produce for the northern hemisphere a climate which would explain the phenomena in a satisfactory manner." "We must only admit," he adds, "that we are face to face with a problem whose solution in all probability must be attempted, and we doubt not completed by the astronomer."

Mr. Taylor, in his "Relations of the Upper and Lower Crags, near Norwich," contended for the existence of four separate "Crags," —the Coralline or most ancient, the Red, the Norwich, and the

Upper or most Modern. The last he regarded as a connecting link with the Glacial series.

In a paper on "The Anglo-Belgian Basin of the Forest-bed of Norfolk and Suffolk, and the Union of England with the Continent during the Glacial period," the Rev. J. Gunn came to the conclusion that the forest bed is the estuarial deposit of some great river or rivers which flowed westwards, closed to the south by a ridge of chalk hills, but open to the sea on the north; and that this ancient river is now represented by the several rivers which flow into the German Ocean between the mouths of the Scheldt and the Rhine. He strongly suspected that the separation of this country from the Continent took place more recently than geologists generally supposed.

In introducing his "Additions to the List of Fossils found in the Boulder Clay of Caithness," Mr. Peach suggested that the clay had been transported to the shores of Caithness by icebergs, which when launched picked up some of the sea bottom with its organisms, and on their voyage, wherever they touched, added to their burthen by picking up more organisms, stones, &c.; that on finally stranding, the mud, stones, sand, and shells of Caithness became intermingled with them; and that when the ice slowly melted the burthen was dropped confusedly together, but was capable, nevertheless, of telling distinctly the story of the voyaging and collecting of the berg.

Mr. Brown, in a communication on "The Drift of the Weaver Hills," described a deposit of siliceous sand, white plastic clay, and other materials, at an elevation of upwards of 1,000 feet, where it is overlaid by the Boulder clay. The author was of opinion that it was not of fresh water origin, and that it was perhaps contemporary with the late Tertiaries—for example, the Norwich crag.

The aim of Mr. Pengelly's paper, "On Raised Beaches," was to call attention to the facts: 1st. That accumulations of blown sand occasionally assume the character of raised beaches. 2nd. That it is not safe to conclude, in the absence of other evidence, that raised beaches differing in height by as much as even thirty feet, necessarily belong to distinct periods. 3rd. That it is possible that what, in a small vertical section having the direction of the coast line, appears to be but one raised beach, may really be two. 4th. That, all other things being the same, raised beaches are likely to be most numerous on a coast composed of durable rocks.

In Dr. Ransom's paper "On the Occurrence of *Felis lynx* as a British Fossil," a description was given of a series of caves or fissures —and especially of one known as the "Yew-tree Cave,"—which on the borders of Nottingham- and Derby- shires occur in the Permian

rocks, and pass through the whole thickness of the Magnesian limestone to an unknown depth in the lower New Red Sandstone beneath. A large number of bones—unrolled and, with one exception, ungnawed, but occasionally much broken—were found embedded in a red loam. Amongst them was a lower jaw, which Professor Owen had identified as that of *Felis lynx* (variety *Cervaria*), a north Asiatic animal, and a fossil new to Britain.

In the "Second Report on the Maltese Caves," Dr. L. Adams, after giving descriptions of the characters and deposits of several Caverns and Fissures in Malta," thus concludes: "From a digest of all the evidence deducible from the geological structure and fossil fauna enumerated in this and the previous report, it may be inferred that the old Miocene formations of which the Maltese group are composed underwent extensive upheavals and formed a considerable tract of land, tenanted by vast herds of hippopotami, elephants, and other quadrupeds, together with birds and reptiles almost all specifically distinct from any species yet found elsewhere, and at a time when the land testacea were identical with those now inhabiting the islands; that at a subsequent period the whole, or at least by far the greater portion, of this area was again submerged, and re-elevated at a still later period, when, after various oscillations of level, the subterranean movements ceased, leaving the present insular fragments."

The "Kent's Cavern Committee" also sent in a "Second Report," from which it appeared that during the twelve months which have elapsed since the First Report was presented, they have carried on their labours in the original rigorous method, and invariably in virgin ground. A large number of bones have been found, but so far as is at present known no new species have been added to the list of animals given last year. Upwards of 70 flint "implements" have been met with, making a total of something more than 100 from the commencement of the work. They resolve themselves into three classes—flakes, and lanceolate, and oval implements. The lower levels of cave earth have, on the whole, yielded fewer tools than the upper, but those found in the lowest zones are the most elaborately finished of the cavern series of implements. A *whetstone* and several pieces of *burnt* bones have been found in the cave earth, with the flints and the remains of the extinct mammals. The Committee observe, in conclusion, that "the careful and unremitting labour bestowed on the cavern during the last year and a half has produced a large accumulation of facts, consistent with one another and with those recorded by the earlier explorers. Of the discoveries made, the uniform testimony is that beneath a thick floor of stalagmite, so difficult to work as to require excellent tools and untiring perseverance, there are everywhere found, inosculating with bones

of extinct mammals, and undoubtedly inhumed at the same time, human industrial remains of a character so humble and so little varied as to betoken a very low type of civilization."

Mr. Spence Bate, in his "Attempt to Approximate the Date of the Flint Flakes of Devon and Cornwall," chiefly confined himself to two localities in Barnstaple Bay, North Devon—one on the north and the other on the south of the mouth of the Taw,—the former being connected with the "Raised beach," the latter with the "Submerged forest"—both long and well known to geologists. From a study of the phenomena, the author concluded "that the flints are more recent than the most recent elevation of land on that coast;" that the submergence of the forest was due, not to any subsidence of the land, but to the slow landward retreat of an extensive "pebble ridge," which formerly protected a low-lying tract of land and enabled trees to grow on an area below the sea level; and that "there is no evidence to show that the flint flakes may not have been coeval with the period that immediately preceded the introduction of Roman civilization into this country."

In the communication by Mr. Oldham, "On the Discovery of Ancient Trees below the Surface of the Land, at the Western Docks now being constructed at Hull," it was stated that at a depth of 40 feet below the level of the adjoining land, trees, some of them of gigantic size, were met with in all positions. They are broken off within three feet of the roots, which still remain *in situ*. It was estimated by the author that they cannot be less than 3,000 years old.

Mr. Peacock gave some account of "A Case of Gradual Change of Form and Position of Land at the South End of the Isle of Walney," stating that the sea encroaches at the average rate of nearly eight feet in width per annum, the land being washed from the west towards the south-east and north-east points, where it remains.

The conclusion at which Mr. Wynne arrived, in his paper on "The Physical Features of the Land as connected with Denudation," was that "both marine and sub-aerial agencies have contributed to form the features of the land, the latter labouring to destroy the traces of the action of the sea, as well as those features which it had itself produced."

Mr. Topley, in his paper on "The Physical Geography of East Yorkshire," stated that his object was to explain the relation of the present surface outlines to the internal structure of the district of Cleveland. He was of opinion that the present scenery of Yorkshire was due not to marine action, but to subaerial denudation.

In his "Report on Dredging amongst the Hebrides," Mr. Gwyn Jeffreys called attention to certain geological considerations of high theoretical interest, and which produced an animated discussion.

Dr. Le Neve Foster stated that the facts of the "Curious Lode or Mineral Vein in New Rosewarne Mine, Gwinear, Cornwall," led him to infer that the fissure which it occupied had been filled partly mechanically and partly chemically, and that the various deposits had been introduced at six different times. The vein, however, was chiefly remarkable on account of its containing rounded pebbles.

Dr. Beke gave a brief account of the island of St. John, in the Red Sea.

Biology. (Section D.)

The title "Biology" was this year adopted for Section D in place of the old one "Zoology and Botany," and it was recommended by the Council of the Association that two special departments should be added to it,—one of Physiology and another of Anthropology. Accordingly Section D had three places of meeting, in which papers were simultaneously read. A large number were thus disposed of, equal in amount to those of any three of the other Sections.

Professor Huxley presided over the Section, while Professor Humphry, of Cambridge, took charge of the Physiological, and Mr. Wallace, the traveller, of the Anthropological department.

On the second day of meeting of the Sections, the departments of Section D were summoned to meet in one room, in order to hear an address from Professor Huxley on the classification and scope of the Biological Sciences, with especial reference to the arrangements made with regard to the departments of Section D. The President commenced by observing that he was afraid some present would be disappointed, as he did not anticipate any controversy, nor any heresy. If any persons should be induced to leave the room in consequence of that statement, he should be very glad. He then proceeded to discuss the nature of Biological Science. All Biological inquiries resolved themselves into either the study of *form* simply, or the *reason* of that form's occurrence. The Embryologist studied a series of forms only, the Anatomist and Histologist studied form, Histology being assuredly nothing but the anatomy of minute parts. The Taxonomist arranged and classified animals with regard to the forms which they presented; the subject of distribution related to the position occupied by various forms of life at the present time on the surface of the

globe, and in past times, when it became an important aid to the geologist, as the Science Palæontology. All these studies had regard only to the form, and did not deal, strictly speaking, with the reason why these forms existed, or their functions in any way. Hence Development, Anatomy, Taxonomy, and Distribution were arranged under the great division Morphology. Physiology was the other great division of Biology; comprising the study of the functions of individuals and their organs, and that other branch of inquiry, of a far wider and more comprehensive nature, the reason of the existence of all forms of life, their mutual relations and the causes which affected their form and habit. This was almost a new study, and its foundations as a science had been laid by Mr. Darwin.

With regard to the arrangements of Section D, it was impossible for one assembly to take interest in and discuss papers on all the branches of Biological Science. The reason of this was to be found in the utter neglect of Scientific education in our schools and the indifference of the Universities. The most philosophical division of the Section would doubtless be divided into two, a Morphological and a Physiological, but this would not be convenient, and it was doubtful if a strictly Physiological Section could be well maintained, since a thorough acquaintance with the Sciences of Physics and Chemistry was necessary for the pursuit of Physiology. The Council of the Association had recommended, purely as a matter of convenience, that a department should be allowed for that numerous body of persons who were pursuing the Science of Man; and that another should be arranged in order to facilitate the discussion of questions in which the medical men who attend the Association are interested, and which have not a general interest. This department would receive the title of Physiology, though the term was used of course in a limited sense.

In the discussion which followed, Dr. Humphry expressed great dissatisfaction with the subordinate position assigned to his department (Physiology). Dr. Hughes Bennett wished for equal sections of "Zoology and Botany" and "Physiology and Anatomy." Sir John Lubbock thought the present arrangement satisfactory, since it prevented the physiologists from taking papers on general anatomy. The President refrained from expressing any opinion; saying that what had been done was done by the Council for convenience.

In the brief notice of the papers read in this Section which we shall give, the papers bearing on systematic Zoology, Anatomy, Development, Distribution, Physiology, and Anthropology, will be taken in order of subjects. First, with regard to general anatomy, zoology, and botany (a vague term, but indicating very well the character of many papers), Professor Alfred Newton read the report

of the committee appointed to investigate the extinct birds of the Mascarene Islands. Almost immediately after the appointment of the committee last year, Mr. George Clarke, of Mauritius, had discovered a large deposit of bones of the Dodo in the swamp known as the "Marcaux Songes." By this now celebrated discovery the whole skeleton of the Dodo had been made known, excepting the end of its wing; whereas before the head and foot at Oxford, the skull at Copenhagen, the foot in London, and the beak at Prague, were all the specimens known of the bird. The committee intend to thoroughly search the marsh for the tip of the Dodo's wing; and also to complete their investigation of the bone-caves of Rodriguez and Bourbon.

Dr. Sclater read a paper on the American Prong-horn *Antilocapra Americana*, in which he pointed out that this animal had characters intermediate between those of the Bovinæ and Cervinæ. The prong-horn had a branching antler like a stag's, but this was covered with a horny sheath, like that of oxen in character. This horny sheath, however, unlike that of any Bovine animal, was periodically cast off, exposing a new horn beneath. This had been observed in the gardens of the Zoological Society in London. Dr. Sclater submitted a classification of the Ruminating Artio-dactyls to the Section, in which he separated the *Antilocapra* from the other Unguligrades. Professor Huxley elucidated Dr. Sclater's paper by some remarks on the nature of horns. He criticized the classification offered by Dr. Sclater, since he considered the Tragulidæ, or musk-deer, as very distinct from the other Ruminants.

Dr. Carmichæl McIntosh read a paper "On a New Molluscoid Animal, a Tunicate," which he had obtained from the west of Scotland. It appeared to be closely allied to Pelonaia, of Forbes and Goodsir. The same gentleman covered the wall of the room with some beautifully coloured and highly-finished drawings of Turbellaria, Annelida, Nudibranchiata, &c., which he had obtained from North Uist, a list of which was submitted to the Section; many of the forms were new. He also exhibited some smaller drawings of great beauty, destined for the Ray Society's volume on British Annelids. Among the specimens shown was one of a deformed star-fish, having completely the form of a human figure. It is very remarkable that another similar specimen is in the national collection.

Mr. C. Stewart, of Plymouth, read a paper "On the Structure of the Echinoidea Regularia, with Special Reference to their Classification." The value of the minute structure of the "lantern" and of the spicules of the alimentary canal, as systematic characters, had been to a great extent overlooked. Mr. Stewart gave, in a condensed form, the result of much laborious investigation among

the Echinodermata, and showed that many minute details in the skeleton were valuable as differentiæ.

A letter from Dr. Carpenter was read with reference to the specimens of *Comatula* procured for him by Mr. Gwyn Jeffreys in the Hybrides. The number of dorsal cirrhi in the specimens of *C. rosacea* was much larger than he had elsewhere observed, whilst the specimens of *C. celtica* were exceedingly fine, almost leading to the belief that they were stunted forms of the splendid *C. Eschrichtii* of Iceland. The presence of very many attached Foraminifera and zoophytes on the *Comatulæ* confirmed Dr. Carpenter in his opinion expressed in his unpublished memoir, in the hands of the Royal Society, that the adult *Comatula* is essentially a stationary animal.

Mr. Ray Lankester described the anatomy and asexual reproduction of *Chætogaster*, a minute worm, one-eighth of an inch long, which clings by hooklets to the bodies of water-snails. He showed that the budding and giving off fresh worms by growth from behind (so that chains of from four to sixteen worms occur) was in this case the result of the tendency to produce three abdominal and one cephalic segment, which the fourth segment always possessed. The most remarkable points in the anatomy of the worm were the very small number of segments constituting an individual—the broad terminal mouth and oral bristles—and the absence of cilia in the whole organism. Professor Huxley said he had observed many of the points mentioned by Mr. Lankester himself, and could speak to his accuracy. He would suggest a comparison between *Chætogaster* and *Sagitta*; he was inclined to consider it as an immature form.

Mr. Henry Woodward, of the British Museum, brought forward an interesting classification of a branch of the Crustacea, in his paper "On the Structure of Limulus, Recent and Fossil." He associated the great *Eurypterus* and *Pterygotus* with the king-crabs of the present day, connecting them by the Limuloid crustaceans of the carboniferous strata, some forms of which he was the first to describe. He drew a parallel between the Decapodous crustaceans and this group. The *Eurypteri* represented the Macroura; the Limuloids and *Hemiaspis*, the Anomoura; while *Limulus* itself, first appearing as early as oolitic strata, represented the Brachyoura. Mr. Woodward had very carefully worked out the number and fusion of somites in the head, thorax, and abdomen of the Limulus itself, and those crustacea he wished to rank with it. Professor Huxley thought that the Eurypterida must be kept distinct from the other crustacea.

Dr. Ransom, of Nottingham, read a paper "On the Structure and Growth of the Ovarian Ovum in Gasterosteus Leiurus," the result of very careful study and observation. Dr. Ransom regards the

germinal spots, which are readily examined in very young ova, as consisting of a material resembling protoplasm only in its great instability and tendency to vacuolate. The action of water and other agents on the tissues of the ovum was carefully discussed. The observation of the dotted structure of the yelk sac has led Dr. Ransom to ascertain that it does not grow by the apposition of either internal or external layers, but by interstitial development. In studying such structures it is very necessary to use a suitable medium. Dr. Ransom recommends a mixture of glycerine and water, which can readily be brought to the right density.

Dr. W. Turner, of Edinburgh, described the very curious method of gestation in a new fish, belonging to the genus *Arius*, which he had received from Ceylon. The female fish deposits her eggs, which are then taken into the mouth of the male, who swims about with them until they hatch. Dr. Turner's correspondent had been very careful to avoid any mistake or imposition in the matter. The fish lived in stagnant pools in marshy ground, where they were caught in large numbers by the natives. Dr. Günther, of the British Museum, said it was very remarkable that in South America there was a fish almost exactly like that which Dr. Turner had described, and Agassiz had lately described several others from the Amazons possessing this curious method of gestation; none, however, had been observed in Africa. Fishes of the most distant regions were often most alike, as, for example, certain species found in Madeira and in Japan.

Dr. Cobbold read one of his horrifying papers "On the Entozoa of the Dog in Relation to Public Health," in which he showed that *Trichina* might be communicated by the dog to man.

Mr. Groom Napier brought forward papers "On the Food and Economic Value of British Butterflies and Moths," and "On the Causes of Variation in the Eggs of British Birds."

Mr. Frank Buckland amused the Section, as is his custom, by a jocose description of Salmon and Oyster fisheries.

In Human Anatomy there was but one paper, but that was of considerable interest, being "On Variations in the great Arterial Blood Vessels," by Dr. G. D. Gibb. The author illustrated the subject by two examples. In the first, the large vessel rising from the heart, called the aorta, gave four branches instead of the usual three, the right carotid and the subclavian, both rising by a distinct and separate trunk, there being necessarily an absence of the innominate artery. In this curious case there was an irregularity in the division of both femoral arteries and in the left sciatic nerve. In the second example, the aorta divided into two great branches; the first of which subdivided into the usual innominate and the left

carotid, which crossed the wind-pipe to the left side. The second branch divided into the left carotid and descending aorta. With regard to the first example it had occasionally been met with by anatomists, but the second the author considered unique, the most experienced observers having failed to record anything similar. He considered this variation in the larger blood vessels as a deviation from the standard or well-recognized ordinary type, and to some extent a precursor of similar conditions in the lower animals. Their occurrence, however, could not be determined during life, nor could any special deduction at present be drawn from them. In the first example, the blood vessels of the extremities had become converted into what might be popularly called cylinders of bone, examples of which were submitted to the Section. Dr. Gibb also illustrated his paper by some well finished drawings.

The papers bearing on the subject of Distribution were very numerous, but have very little interest at present in an isolated form, beyond the bare facts expressed in their titles. Mr. Gwyn Jeffreys read his report on dredging among the Hebrides ; while Mr. H. B. Brady furnished some remarks on the Rhizopod Fauna of those islands; Mr. G. S. Brady reported on the Ostracoda; and the Rev. A. M. Norman gave a list of the Crustacea, Echinodermata, Polyzoa, and Cœlenterata of the same locality. Mr. John Shaw endeavoured to show, in a clever essay, how the distribution of mosses in Great Britain and Ireland was connected with the Geographical and Geological history of the present Flora. The chief points touched on in the paper were of a geological character, such as the gradual glaciation from Miocene periods, breaks in the glacial period, the elevation of land as necessary for the existence of an Alpine, meridian, and southern flora contemporaneously. A similar paper was that by Mr. Hennessy, F.R.S., on the probable cause of the existence of a north European flora in the west of Ireland. Mr. John Hogg, F.R.S., read a paper on the ballast flora of the coasts of Durham and Northumberland; and Mr. Moggridge noticed the occurrence of *Lemna arrhiza* in Epping Forest, and furnished a paper on the zones of the coniferæ from the Mediterranean to the crest of the maritime Alps. Dr. Perceval Wright read some notes and exhibited specimens derived from a botanical tour in the islands of Arran, West of Ireland.

Two papers were read in which the object of the author was to account for certain phenomena by the aid of the theory of natural selection, hence dealing with the "reason why" they would come under Professor Huxley's definition of Physiology in its broad sense. One was a short note by Dr. Perceval Wright, on a moth, *Lithosia caniola*, which occurred in a single bay in the county of Dublin. It had been supposed that this form was introduced by smuggling

vessels from the coast of France where it occurs; but Dr. Wright was of opinion that it was the peculiar climate and condition of the bay which favoured its appearance, or production by natural selection. He had hence been much gratified by discovering the same moth in a bay of identical character, on the south-west coast of Ireland. The other paper alluded to was by Mr. Wallace, the well-known investigator of the Amazons and Malay Archipelago, on Reversed Sexual Characters in a Butterfly, and their interpretation on the theory of modifications and adaptive mimicry. Specimens of the butterflies were exhibited. The *Heliconidæ*, a group of Lepidoptera with an offensive odour, were never taken by birds as food. Whenever they appeared, butterflies of another group accompanied them, the females of which closely resembled the obnoxious Heliconidæ in colour, and hence were avoided by birds, and were able to deposit their eggs and perpetuate their race. Mr. Wallace contended that this imitation could alone be accounted for by the greater immunity which butterflies resembling the Heliconidæ even in a small degree would always possess, the resemblance thus becoming greater and greater in each succeeding generation, by the destruction of those in each brood which bore the least resemblance.

Two papers were read which had reference to the practical application of Biological Science to social economy. Mr. Thomas Browne read a short paper, in which he inveighed against the use of Latin nomenclature and Anglicized Latin, advocating the German plan of using the vernacular, as tending to increase the diffusion and comprehension of scientific truths amongst uneducated persons. A much more valuable paper was that of the Rev. W. Farrar, of Harrow School, "On the Teaching of Natural Science in Public Schools." He expressed his conviction of the necessity and desirability of extensive education in physical science. At Marlborough, Rugby, and Harrow efforts had been made in introducing these studies, and the results of the various methods adopted were compared. He proposed to remove that useless and overwhelming tax on a boy's powers of study, *viz.* verse making, and would substitute some branch or branches of physical science. He felt sure that the masters in our public schools were much in earnest in this matter, and only needed encouragement. Dr. Hooker considered chemistry as too rigid a study for a young boy to commence with, and thought botany and zoology should be the first studies. Professor Tyndall had often witnessed the deep interest boys took in the study of physics, when properly opened to them. The habit of verification by experiment, and the consciousness of a power of prediction, were most important characters to implant in the mind; but this could only be done by a true and philosophic study. Mr. Payne charged men of science with talking in this matter and

not acting. They would not come forward and teach, and they alone could teach as was necessary; hence the slow progress which the movement made. Professor Huxley felt sure that if all men should be as earnest as Mr. Farrar they had nothing to fear. The important question for England just now was not as to her supply of coal, but the necessity of education in the great truths of science.

In the department of Physiology, Dr. Humphry delivered an address opposing the law of Continuity in Life, and Darwinism. Dr. Humphry believes in heterogenesis, subject to certain laws. Dr. John Davy, in a short paper, advanced the view that the carbonate of lime in the egg-shell of birds exists in an amorphous condition. Mr. C. Stewart maintained that the minute aggregations composing the shell had a clearly radiated crystalline structure. A letter was read from Dr. Acland, announcing the refusal of the Medical Council to apply a sum of money to the investigation of the physiological action of medicines, and a paper on this subject was read by Dr. Sharp. Dr. B. W. Richardson reported on the action of Amyl, and exhibited his method of producing local anæsthesia by ether vapours on the person of the President of the Association, into whose arm he stuck needles, &c., without any pain being occasioned. He also read an essay on the Comparative Vitality of Jews and Christians, in which, after adducing a large number of statistics, he offered the conclusion that the great vitality of the Jews is owing to their temperance, faithfulness, cleanliness, and prudence,—not to any traditionary hygienic law or race-characters.

Dr. Spencer Cobbold read papers on the Cattle Plague, Entozoa, and on experiments with Entozoa.

Dr. Gibson made some observations on the movements, structure, and sounds of the Heart; and Dr. Norris read a very long essay on Muscular Irritability and the Relations which exist between Muscle, Nerve, and Blood.

One of the most original and satisfactory papers in this department was by Dr. Arthur Gamgee, "On the Action of Carbonic Oxide on Blood." Dr. Gamgee had followed up Professor Stokes' observations on the spectra of arterial and venous blood. He had found in experimenting with carbonic oxide, that it forms with the colouring matter of the blood a stable compound, having much resemblance to the dark form of cruorine in its absorption bands, but differing from that body in its stability. The hæmato-globuline of blood, when thus combined with carbonic oxide, did not coagulate; hence it was that persons poisoned by charcoal fumes are found to have their blood in a non-coagulable condition. Acetic

acid poured upon such blood set free carbonic oxide, and produced coagulation.

Mr. W. L. Scott read a paper on the presence of Ammonia and its Homologues in the Blood, supporting Dr. Richardson's theory of coagulation. The other papers read in this department were, Dr. Foster, "On a peculiar Change of Colour in a Mulatto;" and, "On an Addition to the Sphygmograph."

The Anthropological subdivision of Section D has done much to restore that branch of science to public favour, and the Committee of the major section showed great wisdom when they invited the eminent traveller, Mr. Wallace, to become its President.

Mr. Wallace delivered a short address, characterized by modesty, conciliation, and liberal sentiment. He claimed for Anthropology the function of inquiring into the nature of Man in all its aspects. His physiology, his anatomy compared with that of the lower animals, his history and palæontology, his psychology, his geographical distribution, his archæological traces, and the study of his skull, brain, and languages, are all included in the noble science of Anthropology; and it is the province of Anthropologists to collect, combine, and systematize all facts bearing upon these questions.

"We cannot afford," he said, "to neglect any facts relating to man, however trivial, unmeaning, or distasteful some of them may appear to us. Each custom, superstition, or belief of savage or of civilized man, may guide us towards an explanation of their origin in common tendencies of the human mind. Each peculiarity of form, colour, or constitution, may give us a clue to the affinities of an obscure race. The Anthropologist must ever bear in mind, that as the object of his study is *man*, nothing pertaining to or characteristic of man can be unworthy of his attention.

"It will be only after we have brought together and arranged all the facts and principles which have been established by the various special studies to which I have alluded, that we shall be in a condition to determine the particular lines of investigation most needed to complete our knowledge of man; and may hope ultimately to arrive at some definite conclusions on the great problems which must interest us all—the questions of the origin, the nature, and the destiny of the human race.

"I would beg you to recollect also, that *here* we must treat all these problems as purely questions of science, to be decided solely by facts, and by legitimate deductions from facts. We can accept no conclusions as authoritative that have not been thus established. Our sole object is to find out for ourselves what is our true nature—to feel our way cautiously step by step into the dark and mysterious past of human history—to study man under every phase

and aspect of his present condition; and from the knowledge thus gained to derive (as we cannot fail to do) some assistance in our attempts to govern and improve uncivilized tribes, some guidance in our own national and individual progress."

Strangely enough, this is the first time that the study of man's nature and history has, in modern times, been viewed in its true character, and "Anthropologists" cannot do better than to stick closely to the principles laid down by their new leader.

Amongst the papers read in this Section subsequent to the President's Address the following are worthy of note:—

Mr. Carter Blake described a human jaw from the Belgian bone caves, which was discovered near Dirant by the Government officials. It was found in undisturbed sandy clay, at a depth of $3\frac{1}{2}$ metres (11 feet 4 in.), the clay alternating with stalagmite, and affording evidences of gradual deposition. The characters which it presented were very different from those exhibited by the jaws of the white races of the present day, and presented in many points an exaggeration of the characters of the lowest Australian jaws. Doubts were expressed by some members of the Section as to the authenticity of the "find," but the President regarded it with great interest.

Professor Huxley read an interesting paper "On two Extreme Forms of Human Crania:" one, that of a Tartar from the Museum of the Royal College of Surgeons; the other, said to have come from New Zealand. The first presented the extreme characters of the brachy-cephalic type, its breadth being 977·1000 of its length; the other was remarkable for its length, which bore to its breadth the proportion of 1000 to 629. In the discussion which followed the paper Dr. Turner stated that he had two skulls, one a Bohemian, the other from Lincolnshire, which in many respects resembled those now exhibited. Mr. Carter Blake expressed the view that artificial pressure had caused the extreme narrowness of the New Zealand skull, and Dr. B. Davis also attributed the extreme measurement of the other skull to artificial causes.

Dr. James Hunt read a paper "On the Cranial Measurements and Personal Attributes of 98 Examples of Norwegians," and pointed out attributes which rendered it undesirable to confound the inhabitants of Sweden with those of Norway.

With regard to the indications of the ancient races by their weapons, &c., some noticeable papers were contributed. Mr. J. W. Flower described a Kjökken-mödding, which he had discovered in the island of Herm, opposite to Guernsey. The shell mound contained bones, &c., and some curious fragments of pottery used for grinding. Sir Edward Belcher exhibited some very curious stone implements belonging to the Esquimaux, which tended to

throw light on the uses of the ancient implements now so much discussed.

Professor Tennant described an Irish Lake Dwelling, discovered by Captain L'Estrange. It appears that lake dwellings existed in Ireland as late as the time of Cromwell; they are also made mention of by the poet Spenser.

Of papers on particular races there were the following:—

Dr. John Beddoe, "On the Stature and Bulk of the Irish." Mr. Bogg, "On the Fishing Indians of Vancouver's Island." Mr. J. K. Lord on the same subject. Consul Hutchinson, "On the Indians of the Paraña." Mr. Collinson, "On the Indians of the Mosquito Territory." Dr. Charnock, "On the People of Andorra." Dr. Gustave Lagneau, "On the Saracens in France." Mr. Ernst "On the Anthropology of Caracas." Dr. Short, "On the Marvar Tribes of India." Professor Leitner, papers from Lahore. Dr. Paul Broca, "On the Anthropology of Lower Brittany." Dr. Mann, "On the Zulu Kaffirs of Natal;" and Mr. Haughton, "On the Land Dayas of Upper Sarawak." Papers of a more comprehensive and philosophical character were those of Mr. Tylor, "On the Phenomena of Higher Civilization traceable to a Rudimental Origin among Savage Tribes," in which the author showed that the most important explanations of present or past unaccountable manners, customs, and superstitions may be obtained by the study of comparative mythology, and by seeking evidence among present savage nations of old customs or superstitions in a modified form. That of Mr. Phillips Day, "On the Power of Rearing Children among Savage Tribes;" and that of Dr. Hunt, "On the Principle of Natural Selection," applied to Anthropology.

The meeting at Nottingham, as far as Section D was concerned, was a successful one, as is shown by the very large number of papers read, all being of a high standard as regards scientific worth, though none were exceptionally, and a few were perhaps not generally, interesting.

We greatly regret that our limited space has prevented us from giving little more than the titles of many interesting papers on those branches of Science included under the general head of Biology, but our readers will readily perceive, from the very scope of the subject, that it is hardly possible to do justice to it in a short summary.

Geography and Ethnology. (Section E.)

The new arrangement decreed by the Council of the Association last year, whereby the science of Man was referred to the Natural History Section and powers given to that Section for the constitution of a department of Anthropology, has not yet had the effect of lessening the number of papers usually read in the Section of Geography and Ethnology. By the new arrangement, all papers treating of the Zoological characters, origin, and primitive history of man are, or ought to be, discarded from the Section which treats of pure Ethnology, and those papers only admitted which describe the observations of travellers on the tribes of distant countries, chiefly in their geographical relations. One or two papers however were read which the Committee of the Section ought, perhaps, not to have admitted. The Section sat six days, and several papers on the programme were left at the last unread.

A trio of famous travellers constituted the chief attraction of the meeting; the names of Baker, Palgrave, and Du Chaillu on the lists of authors of papers drawing together very large audiences. It was computed that 1,200 people were assembled to hear (or, perhaps, rather to see) the gorilla hero; the audiences drawn by Sir Samuel Baker and Mr. Palgrave being somewhat inferior in numbers. The other geographical papers were much inferior in popular interest to the discourses of these three travellers, but there were several of much scientific value and geographical novelty. We will now proceed to give a sketch of the principal subjects brought before the Section.

Sir Samuel Baker commenced the scientific work of the Section, on Thursday the 23rd, by a discourse (it was not a written paper) on the "Relations of the Abyssinian Tributaries of the Nile and the Equatorial Lakes to the Inundations and Fertility of Egypt." Sir Samuel showed himself to be a ready speaker, and the skilful way in which he combined graphic description and amusing narrative with closely-reasoned argument, produced a great effect on his audience. His object was to show, from his own observations, that the annual inundations and fertilizing mud of the lower Nile Valley were produced solely by those tributaries of the great river which have their rise in Abyssinia, and that the outflow from the great lakes near the Equator had simply the effect of keeping up the supply of water when the Abyssinian floods ceased in the dry season. He spent twelve months, from June 1861 to June 1862, in exploring the Abyssinian streams, ascending the banks of the Atbara, and from its upper waters crossing the tributary rivers till he reached the Blue Nile, down which he travelled to Khartum. He described the condition of the Atbara when he first reached its banks, at the close of the dry season. The river is the last tributary which the

Nile receives in its course towards the Mediterranean. From its junction the great river flows through upwards of 14 degrees of latitude, or, allowing for the winding of the bed, about 1,100 miles, through deserts of burning sand, where evaporation and absorption dissipate a large proportion of the water it receives from the upper part of its course. At the junction of the Atbara, the volume of the Nile water is at its maximum. When Baker travelled along the lower part of the course of this important tributary it presented a dry sandy bed, fringed with a few Doum palms and mimosa bushes; not one drop of water flowed from it to the Nile. He proceeded for about 180 miles, and then, on the 23rd of June, witnessed the sudden change which transforms this desert bed into a vast river. The deluging rainfall had commenced in Abyssinia, and the flood came down so rapidly that in a few hours the Atbara, here 500 yards wide, had become a noble stream 20 feet deep. When he had reached the Settite, the principal affluent of the Atbara, which, being situated in a more humid climate, never becomes wholly dry, he discovered the source whence the fertilizing deposit is derived which the Atbara carries down towards the Nile Delta. The country is table-land, covered with rich mould, and the rains sweep this into the streams in such quantity that in the height of the flood the waters of the Atbara become of the consistency of soup.

When sailing up the White or main Nile *en route* to the Equatorial lakes, Sir Samuel observed the great contrast which the river presented to the tributaries he had just visited. He gave a brief outline of his journey from Khartum to the shores of the Albert Lake, and showed that whilst in Abyssinia the rainy season lasts only three months, from June to September, the region of the great lakes has a ten months' rainfall. The outflow from the Albert Nyanza is therefore perennial; it keeps up the supply to Egypt when the Abyssinian inundation has ceased, and prevents the lower Nile from becoming a desert; the supply, moreover, is sufficiently great to overcome the great absorption and evaporation which intervene in flowing through the Nubian deserts. It does not however carry any considerable quantity of fertilizing deposit towards the Delta. Sir Samuel might have here quoted, in support of his views, the authority of Dr. Peney, who made careful measurements of the fluctuations in the Nile-level at Gondokoro, and discovered that there was no regular annual flood and subsidence, but numerous minor fluctuations at intervals of a few days.

Sir Samuel also communicated his ethnological observations to the Section on the last day of the meeting, Wednesday the 29th. It was again an unwritten discourse, and given with a graphic power and humour which delighted the audience. The title given in the programme was "Observations on the Negro Character;" but this gave an inadequate idea of the theme, which was "The

Tribes of Central Africa as influenced by Local Conditions." He gave his observations in the form of a narrative, commencing with his first meeting with true negroes, in sailing up the Nile, in 15° N. lat. All tribes to the north of this were of Semitic derivation, or mongrels of various intermixture. He described the wretched condition of the Aliab, Shyr, and other tribes who inhabit the vast region of morasses extending on either side of the White Nile between 10° and 5° N. lat.; naked savages of emaciated forms and the lowest type of negroes physically and morally. In these regions there was no iron ore or dust and therefore no iron manufacture, one of the causes of the superior condition of the tribes on the higher lands. They are always in a state of semi-starvation, and are driven to grind the bones of animals between stones to make soup of. Among the tribes of the higher lands between 4° N. lat. and the equator, the art of working in iron is everywhere practised, and instruments of great beauty are manufactured. The Unyoro people have even invented a kind of hoe, so ingenious that it might be copied to advantage by Europeans. In those parts of the country, again, which are adapted for cattle, the tsetse fly has great influence; the fly is restricted to certain circumscribed localities; wherever it is present there can be no cattle, and the people are inferior in civilization; wherever it is absent the condition of the people is entirely changed; for the protection of their wealth in cattle necessitates warlike organization and elevates the social character in many other ways. Notwithstanding the many points of difference, the general character of all the tribes was the same. Sir Samuel reiterated that the first step necessary to the improvement of the Central African tribes, was the abolition of the present slave traffic; and that an extensive commerce might be carried on between Europeans and the superior tribes dwelling in the region of the great lakes if this step were taken.

Mr. Palgrave's paper was on the two divisions of Arabia, North and South. He endeavoured to impart some novelty to a subject on which he has already written and lectured so much, by describing in a clear form the physical and social characteristics which distinguish Nejed, the country of Wahabee domination, from Oman, the region which is becoming of growing importance to us.

M. Du Chaillu's paper was entitled "Notes on the Physical Geography and Tribes of Western Equatorial Africa." The subject was generally thought to be ably and scientifically treated; and the audience seemed to be surprised, if not disappointed, that they were not treated to gorilla anecdotes and travellers' tales. The author gave a general description of the country he had traversed during his last journey, showing that with the exception of a belt of low coast land about 80 miles wide, it consisted of a hilly region covered with primitive forests. The land successively rose as he ascended

the hilly ranges which run nearly parallel to the coast, until, 250 miles from the coast, it reached an altitude of 2,500 feet above the sea level. The forest is so continuous that the small tracts of prairie land seemed like islands in a sea of foliage. Nearly all the quadrupeds characteristic of Africa were absent, lion, rhinoceros, giraffe, zebra, ostrich, eland, &c., whilst several apes were peculiar to the region, including the gorilla.

An important paper was read on Monday the 27th, "On a Recent Expedition from Leh to Khotan, in Chinese Tartary." The author was Mr. W. H. Johnson, one of the civil assistants in the Great Trigonometrical Survey of India. This great survey properly terminates in North-western India, at the Karakorum range of the Himalaya; the officers engaged, however, on carrying their triangulations to the summit of these passes, naturally cast a longing eye over the forbidden ground beyond, a region of which nothing as yet is accurately known. Mr. Johnson had the boldness to adventure into this unknown land. He crossed, northward of Leh, the pass of Lumkang (19,533 feet), and reached the elevated plateaux which extend between the Karakorum and the Kiun Lun ranges of mountains. The first plain is about 17,300 feet above the sea level, and bears traces of having been the bed of a large lake; a second plain slopes for a distance of 30 miles, in a north-easterly direction, from 16,700 feet down to 15,300, when it rises again towards the watershed of the Kiun Lun. He struck the Karakash river of Tartary at a point where it is 15,500 feet above the sea-level. Great plains stretched hence towards the east and south-east, but to the west lay a series of deep valleys. Beyond this point Mr. Johnson travelled under the protection of the Khan Badsha of Khotan, who, having shaken off the yoke of the Chinese, was anxious to cultivate friendly relations with the British Government, and invited the adventurous surveyor to visit him in his capital, Ilchi. He sent an escort to meet him, and the march was resumed into the plains of Tartary. It took him sixteen days to travel from the Karakash to Ilchi. He met there with a most friendly reception, and made excursions into the neighbouring country. The city contains a population of 40,000, and is the seat of many manufactures and a busy trade. It is 4,329 feet above the sea-level. At a distance of six miles to the north-east of the city commences the great desert of Gobi, with its shifting sands, which move along in vast billows overpowering everything. The sand is an extremely fine dust resembling pulverized clay, and when it moves the whole atmosphere becomes so dark that Mr. Johnson, at Ilchi, was obliged to use a candle at mid-day to read large print. Where the dust falls it fertilizes the soil, and the province of Khotan is so much enriched by it that the district is more productive than the valley of Kashmere; cotton, silk, and

fruits are produced in great quantities, and Mr. Johnson considered the country far superior to India. Khotan is watered by numerous affluents of the Tarim river, which discharges itself into the great lake Lob Núr; canals have been dug from stream to stream for the irrigation of the country. The return journey was made in November, 1865. The elevated plateau between the Kiun Lun and Karakorum ranges was then in its winter garb, and the cold was so intense that the beards of the party were covered with icicles whilst travelling in the sun. He crossed the Karakorum pass (18,317 feet), and reached Srinagar, the capital of Kashmere, on the 19th December.

The discussion which followed the reading of this remarkable paper was rendered interesting by the part taken in it by Dr. T. Thomson, the well-known Himalayan traveller and botanist, who was the first Englishman who ascended to the summit of the Karakorum pass. Sir Andrew Waugh, late Surveyor-General of India, who read the paper, stated that it was accompanied by an excellent map of the new region surveyed by its author, photo-zincographed from his plane table.

A paper relating to the Pangong lake in the elevated region of Ladakh, lying in the route of Mr. Johnson, from the pen of Captain Godwin-Austen, was also read to the Section, and gave a detailed account of the physical geography and glacial phenomena of the neighbourhood.

The Section was rich in papers on physical geography, for besides the communication of Captain Godwin-Austen just alluded to, there was a remarkable paper by Colonel Tremenheere, on the Lower Indus, which gave in a summary form the results of the author's engineering surveys of the lower course of the river for 540 miles from its mouth. He showed that the Indus flowed along the summit of a ridge, the plain of Sind sloping away from each side of the river as well as downwards towards the sea. The slope of the plain in a direct line to the sea is 9·3 inches per mile, and in many places the transverse slope on each side of the river is quite as much. The soil consists of a very fine silicious deposit, without a single grain of sand as large as a pin-head. The amount of silt carried down annually is sufficient to cover 70 square miles of the sea-bottom with deposit one yard in thickness. It is curious that there exists, in the plain, dry channels far below the actual bed of the Indus; these exist only on the eastern side, and the conclusion must be that the river has gradually worked to the westward. Colonel Tremenheere observed that it might be generally stated of rivers flowing through such plains, that the larger the body of water and the less the surface slope of the plain the more direct will be the course of the river; and, on the con-

trary, the sharpness of the bends of a large river flowing through such a plain will indicate the existence of a considerable slope. The longer a river becomes by extending its delta into the sea, the greater tendency will there be to assume a more direct course. The paper was accompanied by elaborate plans and sections, and contained numerous details and pregnant generalizations which render it of high value. It will probably be read and discussed at an evening meeting of the Geographical Society during the ensuing session.

Another paper of the same class was read by Mr. Markham, "On the Aleppy Mud-bank in South-Western India," showing the existence of a subterranean passage for the fine silt impelled by the back-waters of this part of the coast, under the belt of coast land, into the sea. There was also a physico-geographical paper by Professor Ansted "On the Peninsula of Taman and the Eastern part of the Crimea," which described a line of mud volcanoes at Taman recently visited by the author, and showed that these volcanic outbursts, which changed the geographical outline of this district, formed part of a line of up-heavals which extended a distance of 1,000 miles, and were the remains of the ancient line of elevation when, after the glacial epoch, the regions to the north were raised above the level of the sea. An interesting paper was also communicated by Commander Lindsay Brine "On the Volcanic Eruptions at Santorin," the progress of which he had himself witnessed. He gave the result of soundings in the crater-harbour of the island, which showed how limited was the area of sea-bottom affected by the volcanic disturbance.

Reverting to Africa, there were several papers on different portions of this continent, so fertile in subjects of geographical and popular interest, besides those of Baker and Du Chaillu. Dr. Mann, the Superintendent of Education at Natal, read two papers, which were listened to with great attention, one "On the Physical Geography and Climate of Natal," and the other "On the Kaffirs." Dr. Mann has been for eight years a resident in Natal, and showed himself to have been a close observer, both of its physical phenomena and of the character of its indigenous inhabitants. He gave a very clear sketch of the peculiar configuration of the colony, its land frontier of mountain ridges rising to an average height of 5,400 feet, with their projecting spurs, each having minor spurs in pinnatifid form, graduating in level towards the sea, so that the surface of the land has a gradient from the sea upwards of 1 in 70. Between each ridge lies a deep valley through which flows a stream, and no less than 50 distinct rivers find their way to the sea along 150 miles of coast. Meteorological tables and diagrams were exhibited, and the climate described as a subtropical one, but

softened in its character, the hot season being tempered by daily rains and clouds, which commence in the morning as soon as the sun has gained power, and the cool season attended by clear sunny skies and cold nights. He gave statistics showing the growing productiveness of the colony. Of the Kaffirs he spoke most encouragingly, and gave instances of steady industry, accumulation of property, and appreciation of education among them.

Mr. Thomas Baines read two papers, one "On the Westernmost Branches of the Zambesi," and another "On the Lower Course of the Limpopo," pointing out where further explorations are needed. Dr. Beke also read two papers on African subjects, one "On the Possibility of Diverting the Waters of the Nile into the Red Sea," and one "On the Lake Kura of Arabian Geographers." He quoted numerous historical authorities, and a modern traveller, Schweinfurth, to show that the fertilizing waters of the Atbara might, by the formation of dams, be turned into the Gash, the present dry lower channel of which trends in the direction of the Red Sea. Sir Samuel Baker, in the discussion which followed the reading of this paper, emphatically denied that the bed of the Gash extended to the Red Sea, and stated that there existed no natural facilities for the diversion of the Nile waters. With regard to Lake Kura, which had been placed by Arabian cartographers south of the equator in the position of the newly discovered lakes, Dr. Beke showed that it was no other than the marsh-lake near the junction of the Bahr el Ghazal and the White Nile in 90° N. lat. A paper was also read "On a Recent Visit to Vohimarina," the north-eastern province of Madagascar, by Dr. Ryan, Bishop of Mauritius, describing the harbours, the fertile valleys between the mountains, and contrasting favourably the Betsimsaraka race of that part of Madagascar with the dominant Hovas.

A very interesting paper was read by Mr. R. H. Major "On Priority in Discovery of the Madeira Group," in which the author showed, from the examination of unpublished documents, that the islands were first discovered by Genoese in the first half of the fourteenth century; in proof of which he quoted a map of the date 1351, now existing in the Laurentian library at Florence, in which the group is laid down with its present names. The names were therefore not originally given by the Portuguese in 1418–20 as generally believed. Mr. Major also stated that he had found additional evidence in support of the romantic accidental discovery of Madeira by the Englishman Machim, in a Portuguese manuscript now at Munich, earlier by half a century than the earliest printed account of that adventure.

Besides the papers already mentioned on Asiatic subjects, there were three read to the Section of considerable interest and

importance. One was by Colonel Goldsmid "On a Recent Journey through Eastern Persia and Western Beloochistan," which the author had undertaken in carrying out his duties as surveyor of the new line of the Indian telegraph. Another was by Mr. J. Thomson "On a Recent Visit to the Ruined Cities and Temples of Cambodia."

The third remaining paper on Asiatic subjects was "On the proposed Ethnological Congress at Calcutta," by Sir Walter Elliott. Sir Walter stated that a project had been formed in Calcutta for gathering together, during the great exhibition proposed to be held in 1869–70, living examples of all the races of man of the old world, for Ethnological study; and that a second minor scheme had also been entertained for an assemblage of specimens of the distinct tribes of the Bengal Presidency, to take place at an earlier period. He proposed, himself, a third scheme, intermediate between the two, as more practicable than the first and more widely useful than the second; this was an assemblage of living examples of all the distinct tribes living in British India. He enumerated some of the curious specimens which would, on this plan, be brought to Calcutta, and gave some details of tribal peculiarities. He hoped that European ethnologists would avail themselves of the advantages the proposed congress would offer for the comparison, side by side, of so many types of man.

There were six Ethnological papers read in the Section, besides those already mentioned. Some of these dealt only in generalities, and offered little that need be remarked upon in this place. Two were by the veteran Ethnologist, Mr. J. Crawfurd, on "Julius Cæsar's Account of Britain and its Inhabitants;" and "On the Migration of Cultivated Plants, with reference to Ethnology." They were characterized by the clearness of statement and acuteness of observation which distinguish the venerable President of the Ethnological Society. In the second paper, he advanced the proposition that no tribe or nation ever emerged from the savage condition without the possession of cultivated cerealia, and seemed to imply that it was the nourishment obtained from these grains that influenced the character of nations.

A discussion followed the reading of the paper, in which Mr. Nash and Mr. C. R. Markham showed that the argument did not hold good in some cases. Mr. Nash instanced the ancient Britons and Irish as depending more upon milk and cheese than upon grain; and Mr. Markham showed that the civilized Peruvians of the elevated table-lands around Lake Titicaca lived upon roots, a diet which according to Mr. Crawfurd condemned the tribes that were confined to it to the lowest grade of culture.

The remaining papers on Geographical subjects were one by

Mr. G. Grove, entitled a "Report on the First Expedition of the Palestine Exploration Fund," which has already been made public, and two short notices by Mr. W. Webb and Sir Roderick Murchison; the former giving an account of Dr. Livingstone's recent progress on the Rovuma river, and the latter communicating the welcome news that the remains of the unfortunate Leichhardt expedition had been at length discovered by the search expedition now on its march in the interior of Australia. No details had at present arrived in this country, and the news had only been received during the Association week by Sir Roderick from Dr. Mueller, of Melbourne.

H. W. B.

CHRONICLES OF SCIENCE.

I. AGRICULTURE.

The Cattle Plague—which at the beginning of the past quarter was rapidly declining, still however attacking several hundred fresh cases every week—has at length dwindled to very insignificant proportions; and, excepting for its extreme infectiousness, it is no doubt of less account at present than many other fatal disorders to which the live stock of the farm are ordinarily liable. The returns for the weeks ending Sept. 1 and 8 recorded only 99 and 69 attacks respectively in all Great Britain. Upwards of a quarter of a million cases had occurred during the 52 preceding weeks, of which nearly one-half had died and one-third had been slaughtered, leaving, with a certain number unaccounted for, less than one-sixth as the proportion of recoveries. The third and final report of Her Majesty's Commissioners was published in the month of June, and with the accompanying discussions of all the aspects and relations which the subject presents, it constitutes a perfectly exhaustive treatise on the disastrous experience of the past twelvemonth, which all stockowners should study. In particular, the question of disinfection, which it examines, possesses a permanent interest. This has been most elaborately investigated by Mr. Crookes and Dr. Angus Smith, whose researches are given in full detail. The following is the result of their inquiry as stated by the Commissioners:—

"It is evident that the poison ought to be destroyed at the very moment of evolution or discharge. The disinfectant must therefore not only be both fixed and volatile, but so cheap and easily used as to be continually in action, and it must of course be innocuous to cattle and men.

"A large number of substances which can be used in many other cases as disinfectants must be put aside, as not meeting these necessary conditions. Compounds of iron, zinc, lead, manganese, arsenic, sodium, lime, or charcoal powder, and many other substances, want the volatile disinfecting power; iodine, bromine, nitrous acid, and some other bodies are too dear, or are entirely volatile, or are injurious to the cattle.

"On full consideration, it appears that the choice must lie between chlorine, ozone, sulphur, and the tar acids (carbolic and cresylic). Two of these bodies, *viz.* chlorine, in the shape of chloride of lime and the tar acids, have the great advantage of

being both liquid and aeriform; they can be at once added to discharges, and constantly diffused in the air.

"All these four substances—chlorine, ozone, sulphurous acid, and the tar acids—have been practically tested, either in England or on the Continent, and there is considerable evidence that they all actually do destroy the cattle plague poison. Their precise mode of action is still uncertain. Chlorine and ozone act, no doubt, as powerful oxidisers, converting animal poisons into simple and innocuous substances. Sulphurous acid probably destroys the virus by its strong antiseptic powers. The tar acids, according to the experiments of Mr. Crookes, neither interrupt nor accelerate oxidation, but they act most powerfully in arresting all kinds of fermentative and putrefactive changes, and annihilate with the greatest certainty all the lower forms of life.

"After a full consideration of the relative merits of the four disinfectants, and after some practical trials, Mr. Crookes arrived at the conclusion that the most powerful, and at the same time most simple, process of disinfection would be to use the tar acids as constant liquid and aeriform disinfectants, and sulphur in the form of sulphurous acid as an additional and occasional agency.

"For the reason stated in Mr. Crookes's report, it appears that chloride of lime is inferior to the combined use of carbolic and sulphurous acids. But there is no doubt of the efficacy of this agent, and in certain circumstances, as for the washing of railway trucks, it may be employed in addition to boiling water or steam.

"It is very desirable that the use of carbolic acid should become general throughout the country in uninfected as well as in infected districts. There is little doubt that even were there no danger from the cattle plague, the great purifying effect of this substance on the air of cattle sheds would contribute greatly to the health of the animals."

We presume that a very long experience of the use of carbolic acid is necessary before its permanent efficiency can be determined; but in the mean time its cheapness, easy applicability, and power of at once arresting all kinds of putrefactive change, doubtless justify all that the Commissioners say in its favour.

In connection with this subject we have to add that all attempts, arising out of this national calamity, to establish a National Insurance Society and Fund have failed. Dr. Farr, F.R.S., did, indeed, read a paper last June before a meeting of the English Agricultural Society, advocating a plan which he had drawn up, by which the whole live stock of the country might have been insured by Government upon the voluntary principle; but no action followed upon it. To establish such a society, the first thing necessary was that noblemen and gentlemen interested in agriculture should subscribe to a guarantee fund, on the plan adopted at the

Great Exhibition, and it was proposed that Government should subscribe an equivalent amount, engaging to advance money for preliminary expenses at a moderate rate of interest. The guarantee fund was intended only to make advances or loans, and the subscriptions were to be called for by instalments only in cases of necessity. An appeal should be addressed by the Statistical Department of the Privy Council to all the principal stock owners of the kingdom, requesting their concurrence. The concurrent stock owners would then be requested to send in classified lists of their stock and its value. The premium to be demanded would have to be sufficiently high to cover the risk, and it was believed that 1*s.* per month would insure 10*l.* on a healthy beast exposed to ordinary risks under good arrangements. No beast worth less than 5*l.* should be insured. The policy might be transferred on the sale of cattle being registered. Horses and sheep might be insured upon terms to be agreed upon. Payment of premiums might be made through the post-office. All payments on policies might be made on the authority of a specially-appointed officer in every county, acting under the inspection of the committee. The accounts should be duly audited and published annually, with a digest of the returns and report made by the actuary, to be appointed by the Home Office. All cattle imported diseased should pay adequate premiums, and if healthy, receive policies covering a term of one month or more; the premium in such cases to be collected by the officers of her Majesty's Customs, and paid by them on account of the Society into the Bank of England. No person having cattle uninsured should under any circumstances receive compensation from any public rate. Landlords, for their own protection, might insist upon the insurance of stock, and clauses might be inserted to that effect in the leases or covenants. Under these encouragements it was probable that half the live stock in the kingdom would be insured. This would give an amount of 2,000,000*l.* or 3,000,000*l.*, which would be sufficient to cover all losses and expenses, and whatever profits might accrue should be divided among the insured upon the mutual principle.

These were the main features of the plan; but we fear, with Mr. Torr, who followed Dr. Farr at the meeting in question, that nothing of a purely voluntary character has any chance of being taken up by the farmers of the country on a sufficiently large scale to ensure its success. The occurrence of a great calamity of this kind is so new, and has been so rare, that the lesson of self-preservation which, were it to be of frequent recurrence, it must ultimately teach cannot be expected to be learnt at once.

To turn to the vegetable world, we have in the first place to report the marked success of the Metropolis Sewage Company in growing great crops of Italian rye-grass upon sheer sea-sand.

About 4,000 cubic yards of the sand below Shoeburyness, which is to be the ultimate outfall of the North London sewage culvert, has been spread over an acre of land near Barking. The surface was sown with Italian rye-grass in February last, and the sewage water allowed to trickle over it. Since then several heavy crops have been cut, one of which, grown in a month's time, weighed about ten tons per acre. The efficiency of town sewage, as a feeder of luxuriant vegetable growth, is being tested at other places near the present North London culvert. Mr. Westwood and Mr. Adams, at East Ham, have ten-acre plots which are yielding enormous growths of Italian rye-grass; and at Lodge Farm, near Barking, the Sewage Company are laying down a large extent of land for surface irrigation, so that in a year or two we may hope to see all South Essex convinced of the enormous fertilizing power which is about to be distributed through that district.

The weather of the past summer has been more favourable for succulent growth, such as that of Italian ryegrass, than for the ripening of seeds, and thus we have to report unfavourably of the harvest. A large proportion of recently published reports of the wheat crop declare it to be below an average, and the extremely wet weather of September has much injured grain crops in the later districts.

One other matter of some agricultural interest may be referred to in this Chronicle. The National Agricultural Societies, both in England and Scotland, are trying by means of paid commissions to ascertain with accuracy the experience of farmers in steam cultivation. As the sum of one thousand pounds has been voted for the purpose by the English Society, we may hope soon to have a full report of the costs and difficulties, advantages and returns, which have been hitherto experienced in connection with the various methods by which steam power has of late been applied to the cultivation of the land.

II. ASTRONOMY.

(*Including the Proceedings of the Royal Astronomical Society.*)

During the last few years very close attention has been bestowed by some of our best observers upon the details of the solar surface. The appearance and behaviour of the objects called *willow-leaves*, by Nasmyth, have been observed with especially attentive scrutiny. The variety of names applied to these objects, which have been called *rice-grains* by Stone, *crystals* by Chacornac, *shingle-beach* by Brodie, *coups-de-pinceau* by Secchi, and *corrugations* or *bright*

nodules by Sir W. Herschel, is sufficient to indicate the propriety of the less distinctive name *granules* selected by Messrs. Dawes and Huggins. Hitherto observation has chiefly been confined to the appearance of the granules on those parts of the sun in which the influence of disturbing forces is apparent, as in the areas of the spots. In these regions only is it that the objects assume that lengthened form from which has been derived the comparison to *straws* or *willow-leaves;* and here only, *if anywhere,* do they present the appearance of interlacing, which has been compared by some observers to *thatching.*

In a paper referred to in the last Chronicle, Mr. Huggins presented the results of some observations of the bright granules on those parts of the sun which are free from spots.

The granules are to be observed over the whole surface of the sun excepting the areas containing spots, and they may be seen occasionally unchanged from their normal figures in the penumbræ and umbræ of spots. Observed with powers of about 100 diameters they present an appearance aptly described by Mr. Stone's epithet rice-grains; but when higher powers are applied the granules present less regularity of figure and size. Besides oval and nearly round granules, irregular masses may be observed. The granules do not appear to be flat discs, but bodies of considerable thickness.

These bodies would appear to average about 500 miles in breadth, and from 500 to 600 miles in length; some however are smaller, and occasionally a granule some 1,000 or 1,200 miles in diameter may be seen. Their distribution over the solar surface is very singular. On many parts of the sun they lie in groups, the components of which are separated by small intervals. These groups vary in form, in some places being round or oval cloud-like masses (mistaken probably for single granules by some observers); elsewhere they are long irregularly formed bands. On one occasion Mr. Huggins observed near the centre of the sun's disc "a long oval border of tesselated bright matter, enclosing an area over which the granules were sparsely distributed." To such groups, and to the varying brightness of the material between groups and granules, the coarse mottling of the solar surface visible when the sun is observed with low powers is to be attributed. Mr. Huggins considers that, except in the penumbræ of spots, the granules are not superposed on each other as long as they remain separately recognizable.

What are these bright bodies? Are they, as their appearance suggests, recently condensed incandescent clouds, or, as Mr. Dawes considers them, merely "ridges, waves, hills, or knolls (or whatever else they might be called)" on the surface of comparatively large luminous clouds? Whence, also, "the general approximate

uniformity of size, of form, and of mode of grouping of these incandescent bodies"?

In an essay lately issued M. Chacornac expresses the opinion that the sun is a liquid incandescent mass, surrounded by a dense and imperfectly transparent atmosphere. In this atmosphere solar vapours, raised by evaporation from the liquid nucleus, ascend until they are acted upon by the cold of celestial space, when they condense into luminous crystals. He is of opinion, further, that the sun's spots are caused by the engulfment of vast areas of the photospheric crystals, which lose their brightness as they sink. In this connection we may mention an observation made by Mr. Brodie of "several roundish, isolated portions of luminous matter (having the appearance of icebergs floating on a black sea) in the centre of an umbra."

M. Chacornac discusses, also, the phenomena presented during total eclipses of the sun, Mr. Carrington's discovery that the velocity of rotation of solar spots is a function of solar latitude, and the influence of the planets on the solar atmosphere.

Professor Haughton states that on July 14, 1860, at 2.15 P.M. a meteoric stone fell at Dhurmsalla, the fragments of which were so intensely cold as to benumb the hands of the coolies who picked them up, a peculiarity not easily explicable. The analysis of a fragment sent to the museum of Trinity College, Dublin, presented the following result:—

Chrysolite (peridot or olivine)	47·67
Nickel iron	8·42
Protosulphuret of iron	5·61
Chrome iron	4·16
Minerals insoluble in muriatic acid . . .	34·14
	100·00

Lieut.-Gen. Sabine, Pres. F.R.S., states, in 'Proceedings of the Royal Society,' that from seven years' observations at Kew, compared with observations in other parts of the world, it appears that there is a magnetic variation obviously dependent upon the moon's position relatively to the terrestrial meridian, agreeing in its principal features in various localities. He considers that this variation is "ascribable with great probability to the direct magnetic action of the moon."

In a paper published in the 'Philosophical Magazine,' Mr. Croll has endeavoured to show that the Earth and Moon are approaching each other, and that they will one day be brought together. We have not space to discuss the points raised in this paper, but we believe that the gradual retardation of the Earth's rotation is the only permanent result that can be legitimately ascribed to the action of the tidal wave.

From letters published in the 'Astronomische Nachrichten,' it

appears that the new variable star near ε Coronæ must have risen from below the fifth to the second magnitude in less than four hours, if not quite suddenly.

We have to record the discovery of three new planets. On the 16th of May, Mr. Pogson, Government Astronomer at Madras, discovered a new planet, 11½ mag. On the 20th of June, Professor Peters, of Hamilton College, U.S., discovered another of the same size. On the 6th August, M. Stéphan, Director of the Marseilles Observatory, discovered a new planet (in Capricorn), with the new telescope of that Observatory. The planet is of the ninth magnitude, and was observed in Paris the evening after its discovery. Its position on the night of August 7th was R. A. 20h. 52m. 54·23, S. D. 16° 43′ 57″·1, about ⅔ths of a degree north of the ecliptic. It was retrograding, having lately passed opposition. The numbers of these asteroids will be (87), (88), and (89); Mr. Pogson's has received the name Sylvia; Professor Peters', the name Thisbe.

Proceedings of the Royal Astronomical Society.

In measuring the angles of position of double stars, the most careful observers become aware of a tendency to obtain different results according as the line joining the centres of the stars varies in position. For instance, if the star ε *Boötis* (whose angle of position is about 40° from a declination-circle and 50° from a declination-parallel) is measured (i) when sufficiently *east* of the meridian to bring the components nearly into a vertical line, (ii) on the meridian, and (iii) when so far *west* of the meridian that the components are nearly in a horizontal position, results will be obtained differing always in the same direction, and so pointing decidedly to the varying positions of the star as the cause of the difference. Mr. Dawes explains a simple expedient for determining the amount of error due to such causes, and for correcting results thus affected. This is to be done by placing in an ordinary window-frame a triangular card, having one side vertical and one horizontal, and pierced with holes of varying size, which, taken in pairs, form artificial double stars. These may be viewed with a small telescope, the results of measures taken when the card is placed on one side or the other (of the two at right angles) can be compared, and the existence and amount of error thus determined. Mr. Dawes shows how the necessity for pursuing such a plan of observation for *oblique* positions may be obviated by the use of a small prism "attached to the eye-piece between it and the eye,"—a contrivance which enables the observer to bring a double star in any desired position with respect to a vertical or horizontal line.

M. Otto Struve, after accumulating a large number of double-star measures, became aware of this tendency to error; and to determine its amount and law instituted a series of measures of artificial double stars, set up at a distance from the Pulkova Observatory, and observed with the great equatorial. The results of such observations are of course very valuable, but the plan is clearly not one that can be generally adopted. It becomes important, therefore, to consider whether the objections raised by Struve to the use of the prism proposed by Mr. Dawes are well grounded. Mr. Dawes says, that having for thirty-five years used prisms made by Dollond, Merz, Simms, and Andrew Ross, he has found that no one of them produced sensible deterioration of the image, and that the loss of light is so small that very delicate objects can be observed with this arrangement.

Mr. Pogson presents the results of a series of observations of the planet Mars, with the Madras equatorial and meridian circle. It will be remembered that Major Tennant, Government Astronomer at Madras in 1860, declined (prudently in Mr. Pogson's opinion) to undertake a similar series of observations. The object Mr. Pogson proposed to himself was rather the illustration of the method proposed by Mr. Airy (eight or nine years ago), for the correction of the constant of solar parallax, than the realization of any trustworthy result.

One hundred and fourteen observations were made with twenty comparison stars, between September 22 and October 28, 1862. Owing to the many imperfections of the Madras equatorial, and the low magnifying power employed (63 only), the result was not so satisfactory as Mr. Pogson could have wished, but we think few will agree with him in viewing it as devoid of "any actual value." It affords high evidence of the value of the method proposed by Mr. Airy, and confirms, as far as it goes, the opinion that the long-adopted value (Bessel's) of the parallax requires to be considerably increased. Mr. Pogson's observations give $9''\cdot156$ as the value of the solar parallax. It will be remembered that Hansen, Stone, Leverrier, and Winnecke give, respectively, the values $8''\cdot916$, $8''\cdot943$, $8''\cdot950$, and $8''\cdot964$. Pogson's value differs much less from the mean of these values in excess than Bessel's ($8''\cdot578$) in defect. It is noteworthy that Stone's value is exactly equal to the mean of the four values just named. Adding the two other less trustworthy values, we obtain a mean almost exactly equal to Hansen's.

Mr. Waterston discusses the effects of such a sudden increase of the sun's mass as (in the opinion of many astronomers) seems to be indicated by the sudden blaze of light observed by Messrs. Carrington and Hodgson on September 1st, 1859. He deals first with the opinion some have expressed that the absolute increase of

mass must have been small, since the fall of a mass as large as the earth upon the sun would, "from the conversion of its previous mechanical energy, give out such a blaze as would in a moment scorch up all the inferior planets and probably the earth also."* He finds that even if the blaze were persistent, the general rise of temperature would not exceed 15°; but since the extra power of radiation would only act during the short time occupied by the body in passing through the solar atmosphere before plunging under its surface, the blaze would not be persistent. The general temperature of that part of the sun would be very sensibly increased, but the whole potential radiating power of the sun would not be increased in a perceptible degree. And even assuming that this power were increased 1,000°, yet, since the potential temperature which sends heat enough to maintain the earth's temperature (at an average) 500° above absolute zero is about 12,000,000°, the effect would only be to raise the earth's mean temperature $\frac{1}{24}$th of a degree. Therefore, no perceptible change of climate can be expected to accrue from an accession to the sun's mass approaching the earth in magnitude. "The only indication," he says, "which we can become cognizant of is the possible decrement in the length of the year."

Mr. Waterston proceeds to obtain and apply an approximate formula for determining the amount of this decrement. It results from this formula that a sudden increase of the sun's mass by a mass equal to our earth, occurring at the time of observation (September), would have resulted in a decrease of the major axis of the earth's orbit by 261 miles; and the length of the year would accordingly be diminished by 130 s., corresponding to an acceleration of the sun's mean (apparent) motion by 5″·3 in a year. Had the increase of the sun's mass occurred in July, the major axis would have been diminished by 255 miles, while the decrement would have been no less than 281 miles had the increase of mass occurred in December. In all cases the line of apsides would progress.

It may be remarked that the question of the effect of an increment in the mass of an attracting body has a bearing on a subject that has lately attracted much attention—the acceleration of the moon's mean motion. For it has been calculated by Reichenbach, that, on an average, at least twelve meteoric bodies fall daily upon the earth's surface, so that in 1,000 years upwards of four millions of these bodies must have been added to the earth's mass. Such an increment is almost infinitesimally small, no doubt, compared with the earth's mass, but, so far as it goes, it is an *effective cause* (i) of acceleration of the moon's mean motion, and (ii) of retardation of the earth's rotation.

* 'Monthly Notices,' vol. xx., p. 89.

The extraordinary variable star, lately discovered near ε Coronæ, appears to be identified with No. 2,765 of Argelander's Zone +26°, marked by Argelander as of 9·5 magnitude. Mr. Graham remarks that in Wollaston's catalogue (1790), an object whose place reduced to 1866 also accords with that of the variable, is noted as follows:—"Double (Hers. v. 75) v. v. uneq....dist. 41″...pos^{n} 16° *s. f.*; really quadruple." Also that a nebula is marked on Cary's globe as nearly as possible on the spot occupied by the new star, and that this nebula is not in Herschel's catalogue. Sir John Herschel, on the 9th of June, 1842, marked as visible to the naked eye a star whose place agrees so nearly with that assigned to this star, that "he cannot help believing it to be the same." "If not a new star," he adds, "it is a variable star which merits attention for its own sake."

On May 19th (when the star had diminished to below the 5th magnitude) the Astronomer Royal's spectrum-apparatus was mounted on the great equatorial, and the spectrum of the star was observed at intervals by Messrs. Stone and Carpenter till June 7th, on which day the line near F was "visible but desperately faint." Their observations confirm the results obtained by Mr. Huggins, and described by him in our last Number.

Mr. Browning points out the advantages to be gained by substituting a reflecting prism for the diagonal mirror in a "silvered-glass" Newtonian. The prism reflects more light and with less false-colouring, for it is found that if a prism and a flat mirror placed side by side be made to reflect light from a common source, the circle from the prism is white, while that from the flat is strongly tinted with a reddish-chocolate colour.

III. BOTANY AND VEGETABLE PHYSIOLOGY.

America.—Discovery of a new locality for *Scolopendrium officinarum*.—This fern was first found in America by Pursh, who gives as a habitat in his Flora, 1814, "shady woods among loose rocks in the western parts of New York, near Onondago, in the plantation of J. Geddis, Esq.;" Nuttall in his Genera, 1818, records it as "growing in the western part of the State of New York, in the crevices of calcareous rocks beneath *Abies Canadensis* and *Taxus Canadensis*;" and Dr. Asa Gray, in the Botany of the Northern United States, mentions as a station, "limestone rocks, in a deep ravine at Chittenango Creek, below the Falls, where it abounds." In May last, a new locality, where the Scolopendrium grows abundantly, was discovered in the United States by Lewis Foote, Esq., of Detroit, in the township of De Witt, about five

miles from Syracuse and within a few miles from Onondago. A dried specimen was immediately sent to Dr. Asa Gray by the fortunate discoverer.

Messrs. Sullivant and Lesquereux, well known as the ablest Cryptogamic Botanists in the United States, have issued a second and greatly enlarged edition of their 'Musci Boreali Americani, sive Specimina Exsiccata Muscorum in Americæ Republicis Fœderatis detectorum' (the mosses of North America, or dried specimens of mosses detected in the Federal Republic of America). This edition is not a mere reproduction of the first, for whilst that contained a little over 400 species or marked varieties, this contains 536. The novelties in the second edition are partly from California, and contributed mainly by the zealous Bolander, also from the Rocky Mountains by Mr. E. Hall, and there are many new eastern species which have been detected by Messrs. James, Peck, Austin, Clinton, and Ingraham, as well as by Lesquereux himself. The price of the set is thirty-five dollars, or 7*l*. Each copy is accompanied by an octavo pamphlet of 96 pages, being a representation, in convenient printed form, of all the tickets characteristic of the new species, and an index. Applicants will address, M. Leo Lesquereux, Columbus, Ohio.

In a letter, dated March 26, 1866, which is published in the May number of 'Silliman's American Journal of Science and Art,' Professor Brewer gives some interesting facts as to the occurrence of living plants in the hot and saline waters of California. He says:—"The so-called Geysers in Pluton Creek, a branch of the Russian river, lying at an altitude of 1,700 feet above the sea, consist of numerous steam vents and hot springs of various temperatures, the hottest observed being 97° Centigrade, or about 207° Fahr. In these warm mineral waters low forms of vegetation occur, consisting of unicellular plants and filamentous Confervæ of a bright green colour. They were most abundant in waters of the temperature of 52° to 60° Centigrade, or 125° to 140° Fahr. The highest temperature noted in which the plants were growing was 93° Centigrade, or about 200° Fahr. The plants were unicellular in the hottest springs, and filamentous in springs of a lower temperature. These observations were made in November, 1861, and the facts were communicated, the following winter, to the California Academy of Natural Sciences." As a remarkable example of tenacity of life amongst the higher plants, *Lewisia rediviva* is mentioned, a Portulacaceous plant, large flowered and fleshy, growing in British Columbia, Oregon, and California. Specimens of this plant will grow, although they have been dried and in the herbarium for two or three years, and indeed the samples are often troublesome from sprouting whilst between the papers. One species collected by Dr. Lyall, of the British navy, was

"immersed in boiling water" to stop this growing propensity before submitting to the drying process, and yet more than a year and a half afterwards it showed symptoms of vitality, and in May, 1863, it produced its beautiful flowers in the Royal Gardens at Kew. This plant is figured in 'Curtis's Botanical Magazine' for August, 1863.

BELGIUM.—*The Cryptogamic Origin of Intermittent or Marsh Fevers.*—The writings of Dr. Salisbury on this subject have induced Dr. Hannon, Professor of Botany in the University of Brussels, to send to the 'Journal de Médecine de Bruxelles, Avril, 1866,' a very interesting letter on the same topic, from which it appears that Dr. Hannon entertains precisely the same views as Dr. Salisbury, on the influence which the spores of the algæ which grow in the marshes exercise in the genesis of these fevers, but he assures us that the facts contended for by the distinguished English physician have been long known in Belgium. "In 1843," says Dr. H., "I studied at the University of Liege. Professor Charles Morren had created in me such an amount of enthusiasm in the study of the physiology of the fresh-water algæ, that the windows and mantelpiece of my chamber were encumbered with plates filled with *Vaucheria, Oscillatoria* and Confervæ. My preceptor conversed with pleasure on my observations on these algæ, and each time he said to me, 'Take care, at the period of their fructification the spores of the algæ give intermittent fever. I have had it every time that I have studed them too closely.' As I cultivated my algæ in pure water and not in the water of the marsh where I had gathered them, I did not attach any importance to his remark. I suffered for my carelessness. A month later, at the period of their fructification, I was taken with a shivering; my teeth chattered; I had the fever, which lasted six weeks. I removed from Liege to Brussels and recovered under the treatment of Dr. Alphonse Leclercq. I related to Professor Morren what had happened to me. 'You see,' said he, 'that I was right; and you are not the only one that I have known become fevered through a similar cause.'"

AUSTRIA.—Professor Unger has communicated to the Imperial Academy of Sciences at Vienna, a paper on the vegetable and animal remains and relics of manufacturing art, contained in a brick taken from one of the Egyptian pyramids. He examined a brick from the pyramid of Dashour, which dates back from between 3400 and 3300 B.C., and found imbedded in the Nile mud or slime of which it is composed, animal and vegetable remains so perfectly preserved that he had no difficulty whatever in identifying them. Besides two sorts of grain he found the following familiar plants, *Pisum arvense, Linum usitatissimum, Raphanus raphanistrum, Chrysanthemum segetum, Euphorbia helioscopia, Chenopo-*

dium murale, Bupleurum aristatum, and *Vicia sativa.* The brick contained chopped straw, thus confirming the account of the brick-making given in Exodus. The manufacturing relics consisted of fragments of burnt tile, pottery, and a small piece of twine spun from flax and sheep's wool, significant of the advance which civilization had made more than 5,000 years ago. Professor Unger thinks that by a careful examination of a large number of bricks, much light may be thrown on the civilization of ancient Egypt. The bricks also contained abundant remains of fresh-water shells, insects, fishes, &c.

England.—*Discovery of a new British Lemnaceous Plant, the Wolffia arrhiza* (Wimmer).—Mr. Henry Trimen, M.B., F.L.S., has given a description of this plant in the August number of the 'Journal of Botany.' It is the smallest of our Phanerogams, and was found by Mr. Trimen in a pond near Staines, Middlesex, where it grows in abundance, floating on the surface of the water between the fronds of *Lemna polyrrhiza, L. gibba,* and *L. minor.* This minute plant has a very extensive geographical range, being found in Portugal, France, Italy, Switzerland, Germany, Bengal, Eastern Java, Angola, Egypt, and New Orleans. This species has since been detected in the Kew herbarium, dried, amongst samples of *Lemna minor,* and not named. Since the above discovery was made, a new station of this plant has been found by Mr. M. Moggridge, in a pool near St. James's Church, Walthamstow, Essex. As the *Wolffia arrhiza* is smaller than a pin's head, and occurs in company with other duck-weeds, it is probable that it exists in many other localities, and might be found if such places were carefully examined. Dr. Gray, of the British Museum, thinks that this plant is not a recent importation to England, as about 50 years ago Mr. Bennett and himself had some specimens of it brought to them by M. Gerard, which were found on Putney Common. M. Gerard maintained that it was *Lemna arrhiza,* but Dr. Gray thought at the time that "it was only a young state of *Lemna minor,* for the difference between the fructification of the two plants had not been then described."*

The Lemnaceæ of British India have also been described by Mr. Sulpiz Kurze, Curator of the Herbarium of the Royal Botanical Gardens, Calcutta. Seven species are enumerated, two of which are new, and, so far as at present is known, restricted to India, *viz. Wolffia microscopica,* Kurz., and *Lemna oligorrhiza,* Kurz. Duck-weeds, therefore, occur nearly as generally in the tropics as in northern countries, though a moist region, covered with tanks and rivers, is more favourable to them than a dry one. Bengal is rich, not only in species, but in the number of individuals. As to the

* See 'Journal of Botany,' August, 1866.

vertical distribution of these small water-plants in India, the individuals and species decrease in number as we ascend the mountains. At Java, 5,000 feet above the sea, where lakes and pools abound, scarcely any duck-weeds exist. In Laboul, however, *Lemna minor*, the only species known in that district, ascends to 9,500 feet.*

The Herbarium of the British Museum.—From the official report of the Botanical department published recently, we learn that during the year 1865 the following additions have been made to the collection:—1,500 species of plants in the form of a herbarium; 269 species of plants from the Shetland Islands; 250 British fungi; 5 microscopic fungi; a monograph of British Cladoniæ, containing 80 species; 269 species of Swedish plants; 200 plants, forming cent. 34 and 35 of Billot's 'Flora Gallicæ;' 1,000 species from the Tyrol; 100 Italian species, being fasciculi 23 and 24 of the 'Erbario Crittogamico Italiano;' 400 of the rarer plants of Sicily; 76 roses; 273 European mosses; 100 fungi; 130 algæ; 30 microscopic slides of Diatomaceæ; 1,078 species of South African plants; 1,600 from the Zulu country; 2,850 from Venezuela; 2,127 from Cuba; 2,000 garden specimens from Mr. John Smith's Collection; and 100 fruits and seeds from Mexico: altogether, 13,027 species, the accumulations of a single year.

Mr. M. C. Cooke publishes a valuable paper on leaf Sphæriæ, in the 'Journal of Botany,' August, 1866, containing descriptions of 28 species, eleven of which are new to science, and therefore described by Mr. Cooke for the first time. Eight of these novelties were collected by Dr. Edward Capron, of Shere, Surrey, and the remaining three were gathered by Mr. Cooke. All interested in the study of microscopic fungi will give due credit to these gentlemen for thus contributing to our knowledge of leaf Sphæriæ. The following are the names and habitats of the new species:—

Venturia Myrtilli: on semi-putrid leaves of *Vaccinium Myrtillus*. *Venturia licifolia:* on semi-putrid leaves of Holly. *Sphærella oblivia:* on under-surface of dead Chesnut leaves. *Sphærella arcana:* on dead leaves of Castanea vesca. *Sphærella simulans:* on dead Oak leaves, Highgate, 1866. *Sphærella punctoidea:* on upper surface of Oak leaves. *Sphærella millegrana:* on upper surface of dead leaves of Hornbeam. *Sphærella latebrosa:* on dead leaves of Sycamore. *Sphærella Acerifera:* on dead leaves of *Acer campestris*. *Sphærella inequalis:* on dead leaves of *Pyrus aria*. *Sphærella Vaccinii:* on semi-putrid leaves of *Vaccinium Myrtillus*.

France.—*New Paper from Vegetable Matter.*—M. Cannisade has taken a patent in France for the manufacture of paper from the

* See 'Journal of the Linnean Society,' vol. ix., No. 37.

roots of the Lucerne. When these roots are dried and crushed they leave visible thousands of very white fibres, which form an excellent pulp for the manufacture of paper, and a good substitute for rags. The species of Lucerne employed for this purpose are *Medicago media*, *M. falcata*, and *M. maculata*.*

A paper, entitled "Investigations as to the Rottenness of Fruits and other parts of Living Vegetables," by M. C. Davaine, has been communicated by M. Ch. Robin, to the French Academy, and appears in 'Comptes Rendus,' No. 8, August 20, 1866. The experiments of M. C. Davaine recorded in this paper prove that the rottenness of fruits is the result of the attacks of fungi, the different varieties in the form of the decay being produced by generic differences in the attacking fungi by the spores of which the fruit has been inoculated. Thus the rottenness determined by a *Mucor* or a *Penicillium* differs in density and colour as well as in rapidity of development; and all the other Mucedineæ produce a rottenness so characteristic, that the name of the fungus which produced the mischief may be at once determined; for example, a *Helminthosporium* which attacks the carrot, produces a black putridity; a *Selenosporium?* Corda, which M. Davaine observed upon the cucumber, and which he propagated on this fruit, gives a beautiful red colour to the flesh of the cucumber, whilst the rottenness of the same fruit resulting from the invasion of a *Mucor* or a *Penicillium* has no particular coloration. M. Davaine deduces the following conclusions from his experiments:—1. The common Mucedineæ which develope on inert substances are able also to be generated on living organisms, and it is not necessary that the organism should be altered by disease in order to form a suitable nidus for the development of the spores; it is sufficient that the tissues be inoculated with them even when in a state of health. 2. The consequences resulting from the development of these fungi is a profound alteration of the tissues or structure of the part of the plant invaded, designated commonly by the term rottenness. 3. This rottenness varies with the character of the Mucedineæ by which it is determined; the most usual conditions under which rottenness developes being atmospheric humidity.

IV. CHEMISTRY.

(*Including the Proceedings of the Chemical Society.*)

M. Stas, of Brussels, has for many years been engaged upon experiments to determine the atomic weights of a few simple bodies.

* See 'Journal de Chemie Médicale de Pharmacie de Toxicologie,' par M. A. Chevallier, August, 1866.

They have been carried out on such a scale and with such precautions as are without example in chemical investigations. The primary object of M. Stas was to ascertain the truth or falsehood of Prout's theory, that the atomic weights of all simple bodies are multiples of that of hydrogen; the result has been to convince the author that the theory is without foundation in fact. We append a few of the author's determinations, reserving a fuller notice of his experiments for a future occasion. Taking then hydrogen as the unit, the atomic weight of oxygen will be 15·960; of chlorine, 35·368; of iodine, 126·533; of potassium, 39·040; of sodium, 22·980; and of silver, 107·660.

Schönbein has published another contribution to the knowledge of Peroxide of Hydrogen. In this paper he gives an easy method of producing a weak solution of the body, which will probably answer to make the tests subsequently described. A small quantity of amalgamated zinc turnings and a little water are shaken for a few minutes in a flask or bottle containing either pure oxygen or atmospheric air. By this a little oxide of zinc is formed, and the water is found to contain a small amount of peroxide of hydrogen. The author states that a strip of white filter paper dipped in a solution containing only one-half per cent. of the peroxide, and then dried in the air at the ordinary temperature, will show all the reactions of the peroxide. When touched with a solution of acetate of lead it will turn brownish yellow, and when touched with a dilute solution of ferrous sulphate with iodide of potassium and starch, it will be instantly coloured the deepest blue. Schönbein further tells us that although peroxide of hydrogen is volatile, a solution may be concentrated by boiling and indeed almost dehydrated by evaporation over sulphuric acid and under an air-pump. As showing the condition of the oxygen in the peroxide, the author mentions that a strip of paper dipped in a solution of the latter, and then suspended in a bottle of ozonized air soon ceases to exhibit the reactions of the peroxide, while the end of the strip left outside the bottle continues to show them for hours.

The fact that oxygen combines with metals in different conditions receives further support from an experiment described by Dr. W. Schmid. This chemist has found that an excess of freshly precipitated peroxide of manganese placed in a solution of sulphate of copper causes the precipitation of the latter metal in the form of peroxide, the manganese passing into solution as sulphate.

In the list of elements in many works on chemistry the name of a supposed metal, Norium, is placed, said to have been discovered by Svanberg in 1845. The discoverer thought he had proved that zirconia was a mixture of two earths. Recent researches by R. Hermann have however shown that sufficient differences exist in zirconia of various origins, mainly depending on the presence of

alumina, to account for the facts on which Svanberg based his fancied discovery. A variety of researches by R. Hermann on the rarer earths will be found in No. 6 of the 'Journal für praktische Chemie' for this year.

Dr. Rudolph Wagner has found that the rare metal Indium is to be met with in the flue dust of zinc ovens, where indeed it might naturally be looked for. The fact is worth mentioning, and we believe it would repay a chemist to examine the flue dust wherever blende is roasted.

The same author has also published a process for the extraction of mercury from poor cinnabars, partly in the moist way. He treats the ore with a hot solution of sulphide of barium, which dissolves the sulphide of mercury, to be precipitated again by the addition of hydrochloric acid. The sulphide so obtained can be reduced or used directly for the preparation of mercurial salts. Incidentally the author gives a process that can be applied to the valuation of the ore. Cinnabar he finds is in the course of a day or two completely decomposed by a solution of iodine in iodide of potassium, iodide of mercury being formed, and sulphur set free. The difference in the amount of free iodine, ascertained by means of hyposulphite of soda, will show how much has combined with mercury, and consequently how much mercury is present.

M. Roussin has suggested the use of the metal Magnesium in toxicological examinations. It rapidly and completely precipitates the poisonous metals without the risk of introducing another to complicate or falsify the results. It can also be used in a Marsh's apparatus in place of zinc with the utmost confidence, since it has been shown by Professor Wanklyn, as well as by M. Roussin, that commercial magnesium is perfectly pure.

We have in former numbers mentioned the new analyses of Harrogate waters, and may here add that further investigations by Dr. Muspratt and Mr. R. H. Davies have revealed the presence of lithia and strontia in all the springs. Mr. Davis has found as much as 3·242 grains of carbonate of strontia in a gallon of the water of the Old Sulphur Well, and 2·815 grains in the Kissingen spring. The amount of lithia has not been determined; but its presence has been recognized by means of the spectroscope. Continual changes seem to be taking place in the saline constituents of the Harrogate waters, barium salts, together with the strontia, and probably the lithia having appeared within the last few years. No one of these bodies was detected by Dr. Hofmann in 1854.

One of the most important papers on technical Chemistry published during the past quarter is the second part of the Memoir of M. Kolb "On the Manufacture of Soda by Leblanc's Process." As this is a most important branch of industry in this country, where upwards of a thousand tons of common salt are daily consumed in

the manufacture, we may direct the reader's attention to the original memoir, which will be found in the 'Annales de Physique et de Chimie' for June, 1866, or to a full abstract in the 'Chemical News,' Nos. 345, 347, and 348. The most important point brought out by the elaborate researches of the author is the necessity for rapidly lixiviating the ash, and the great desideratum of the manufacture at present is a system of apparatus to accomplish this.

Mr. Walter Weldon has devised and patented a process intended to supersede Leblanc's; but we are not aware that its practicability on a large scale has yet been demonstrated. The chemistry of the process is very simple. The inventor places in a vessel capable of withstanding great pressure an equivalent of common salt and an equivalent of carbonate of magnesia together with a little water. Carbonic acid gas, obtained by the cheapest means, is then forced in, to convert the carbonate into bicarbonate of magnesia. The solution of this salt, it is said, decomposes the chloride of sodium, producing bicarbonate of soda, which is precipitated, and chloride of magnesium, which remains in solution. A very moderate temperature will, of course, reduce the bicarbonate to carbonate of soda. The solution of chloride of magnesium is evaporated to dryness and the residue ignited, whereby the chlorine is driven off and magnesia left for another operation.

A very important contribution to Physiological Chemistry has been made by M. Melsens. It is well known that chlorate of potassium and iodide of potassium do not react on each other when brought together under ordinary circumstances, and that either may be administered to an animal without producing any toxic effect. But when these two salts are administered together the author finds that iodate of potash is formed in the body and the animal is poisoned.

The various albumenoid bodies of both animal and vegetable origin have undergone a tolerably complete investigation by Dr. A. Commaille, of whose thesis a full abstract is published in the 'Journal de Pharmacie et de Chimie' for August. The author's researches, and indeed those of other chemists, on white of egg seem to prove that sulphur is not an essential constituent of the albumen, but is contained in a volatile principle perfectly distinct. However that may be, it is shown that the sulphur is set free when the albumen is coagulated by heat. Raw white of egg has no action on silver, which is blackened, and indeed corroded, by contact with the coagulated albumen.

In the gluten of wheat the author finds as many as five distinct nitrogenized principles, in the blood three, and in milk also three. "The land of protein bodies," it has been said, "is a land full of undefined shapes which only here and there present a well-marked form, and their investigation constitutes a series of

problems among the most abstruse to be met with in the whole range of animal chemistry." Dr. Commaille's memoir is an important contribution to our knowledge of these ill-defined shapes.

On advanced Organic Chemistry, it is hardly necessary to say that a large number of papers have been published, but for these we must refer our readers to journals specially devoted to the science.

Among recent publications on Chemistry, we may direct attention to a very useful little manual by Dr. Roscoe, entitled 'Lessons in Elementary Chemistry.'* It forms an admirable introduction to the study of the science on modern principles.

Proceedings of the Chemical Society.

On June 7, Professor Wanklyn read a paper "On the Oxidation-products of the Propione produced from Carbonic Oxide and Sodium Ethyl;" Mr. E. T. Chapman gave an account of "Some Decompositions of Nitrite of Amyl;" and Mr. Bassett described "A Cyanogen Derivative of Marsh Gas." Abstracts were also read of papers by Drs. Stenhouse and Müller "On the Preparation of Chrysammic Acid and Chrysammic Ether;" by Professor Kolbe and G. Wirchen, entitled "A Preliminary Notice of Phthalic Aldehyde;" and the title of a paper by the late Mr. E. A. Hadow was read. This paper, which gives the results of some of the latest work of its skilful and conscientious author, is on the Platinum bases; the best mode of obtaining and identifying them.

At the same meeting Mr. A. Vernon Harcourt delivered a lecture "On the Course of Chemical Change."

On June 21, Dr. F. C. Calvert gave an account of some experiments made by himself and Mr. Johnson "On the Action of Acids upon Metals and Alloys."

These experiments possess great scientific as well as practical value, since they have led the authors to the following established conclusions: 1. That the extent of action of any acid upon an alloy cannot always be predicted from the known effects of the same acid upon individual metals. 2. That a variation in the proportion of the constituent metals, no greater even than 10 per cent., will sometimes entirely change the character of an alloy, so far as regards its corrosion by and solubility in acids. 3. That the influence of water in modifying the action of acids on metals and alloys is, in nearly all cases, very considerable. Among the most interesting of the results were those obtained by the action of sulphuric acid of various strengths on pure zinc. With monohy-

* Macmillan & Co., 1866.

drated acid there was no action in the cold, but on heating to 150° C. the metal dissolved, and sulphurous acid was disengaged. With tetra- and penta- hydrated sulphuric acid, much sulphuretted hydrogen was evolved, and only traces of sulphurous acid. With acids containing seven atoms of water and upwards, only hydrogen was given off. We must refer our readers to the 'Journal of the Chemical Society' for the complete results of these valuable and interesting experiments.

At the same meeting Dr. Debus gave a short discourse "On the Constitution of some Carbon Compounds."

An extraordinary meeting of the Society was held on July 5 to dispose of the remaining papers, and to hear a discourse by Professor Williamson "On the Constitution and Representation of Organic Compounds." The best idea of the author's system will be given by quoting a few of his formulæ: Alcohol, $H_3 \{ C. C. \ddot{O}. H.^{H_2}$; oxalic acid, $H. O. \ddot{C}. \ddot{C}. O. H.^{O. O.}$ Professor Williamson claimed for his system the merit of greater simplicity than those of Kekulé and Crum Brown; but the length to which the formulæ of some bodies written upon the system must extend, will be a great objection to its adoption.

Mr. W. Thorp afterwards read a paper "On the Reduction of Oxides of Nitrogen by Metallic Copper in Organic Analysis," in which the author showed that in determining nitrogen by volume, as in Dumas' method, it is essential to maintain the heat at bright redness, and to pass the gas very slowly over the copper.

A note "On the Hydrocarbons contained in Crude Benzol," by Mr. C. Schorlemmer, was also read. We referred in our last to the discovery by the author of a new series of hydrocarbons in coal-tar. The author has, in fact, obtained by the treatment of crude benzol with bromine a body having the composition $C_6 H_{10} Br_4$, from which he infers that besides the members of the olefine series crude benzol contains the hydrocarbon $C_6 H_{10}$, identical, he believes, with the hexoylene of M. Caventou.

It is worth mentioning here, that to prepare perfectly pure benzol, Mr. Schorlemmer recommends treatment of the crude mixture of hydrocarbons with bromine, and subsequently with potash before rectification. In this way a product is obtained which gives a nearly colourless nitro-benzol, and dissolves in concentrated sulphuric acid without much coloration.

V. ENTOMOLOGY.

(Including the Proceedings of the Entomological Society.)

The old opinion as to the hermaphroditism of the viviparous Aphides has been revived by M. Balbiani. According to his statement in the 'Comptes Rendus,' the main facts seem to be that the vitelline vesicle separates into two cells, and that each of these cells subsequently becomes covered on its surface by a generation of small cells which gradually increase in size and number. From these two cellular groups, placed side by side in the cavity of the blastoderm, originate the male and female elements of the future animal—that is to say, of the ova in the one and the spermatic fecundating corpuscules in the other. The formation of the spermatic bodies commences very early, for all the embryos of the viviparous aphides at the moment of their birth contain new generations in the course of development. The observations which M. Balbiani has made indicate, he thinks, that the egg, while in the ovary, undergoes a first fecundation with which the male has nothing to do, and the effect of which is limited to the generation of the elements of the future animal. In the oviparous aphides the formation of the embryo does not commence until after the fecundation by the male and the deposition of the egg which succeeds.

In the 'Annales de Sciences Naturelles, Zoologie' (July, 1866), M. Meinert calls attention to two articles published by him in the 'Naturhistorik Tidsskrift,' the one sustaining the opinion of the origin of the Cecidomya larvæ in the adipose tissue against the opinion of M. Pagenstecher (ante, p. 269); and the second asserting that the statements of various observers have been drawn from two different forms belonging to very different genera —the *Miastor metraloas* (the one on which Professor Wagner's discovery rested), and a hitherto undescribed species which he has characterized under the name of *Oligarces paradoxus;* in neither is there formed an ovary properly so called, as M. Leuckart has asserted. The egg he considers to consist of a single cell, "la cellule germinative."

Dr. Packard has communicated to the 'Annals and Magazine of Natural History' (August, 1866), a paper recently read before the Boston (U.S.) Natural History Society, entitled "Observations on the Development and Position of the Hymenoptera, with Notes on the Morphology of Insects." The "observations" were chiefly made on the genus Bombus, and its successive stages are minutely described. The author considers that twenty rings, or somites—for which he proposes a new name (*arthromere*)—as a rule, compose the body of insects, of which seven are contained in the head,

three in the thorax, and ten in the abdomen. We may observe, however, that Professor Huxley, taking the moveable appendages as the test of the number of rings, came to the conclusion that "never more than six, and never fewer than four, somites enter into the composition of the head" in the Arthropoda generally, while in insects he limits them to five. In a masterly article, however, in a former volume of the same series,* from which we have just quoted, the late Dr. Schaum throws considerable doubt on the hypothesis of a separate cephalic segmentation. We have not space here to enter into his arguments, which we believe have not hitherto been answered. Perhaps one of the strongest is that there is never more than one ganglion in the head, while in the larvæ with homonomous segments the ganglia correspond to the segments.

The Mountain Silk of North China is likely to become an article of commerce. Mr. Consul Meadows reports that there are two crops in the year—a spring crop of greatly superior quality, and an autumn crop much more abundant than the former. The autumn cocoons intended for the spring crop are exposed nearly all the winter to a temperature considerably below the freezing point, notwithstanding which the moth comes forth in the first warm days of spring; eggs are produced in four or five days, and in a few days more the caterpillars are hatched. These are soon transferred to the oaks on the hill-sides, and when they have acquired their full size they commence forming their cocoons. The chrysalids which are not kept for breeding are used by the Chinese as an article of food.

A new work, entitled 'Rhopalocera Africæ Australis,' has just been received in London. It is an account of the butterflies of the Cape Colony, by Mr. Roland Trimen, an accomplished entomologist, well known for the years of study which he has bestowed on the African diurnal Lepidoptera. Although a colonial publication, it is quite equal in its "getting up" to the average of English works of the same class.

Entomological Society.

June.—Professor Brayley communicated an extract from the report of Mr. Consul Zohrab, respecting the occurrence of a venomous spider in the corn-fields of Berdiansk, from the bite of which many persons had suffered severely. Mr. Pascoe exhibited a small collection of Coleoptera from Western Australia, made by the Rev. George Bostock, of Freemantle. They were found principally in ants' nests. Among them was a remarkably isolated

* Vol. xi., p. 173 (1863).

genus of an entirely new type of form, having, however, from its three-jointed antennæ a certain analogy with the Paussidæ. It was described under the name of *Ectrephes formicarum*. Descriptions of other curious species were also laid before the meeting. Mr. Stainton made some observations on the difficulties of determining the species of *Gelechia* feeding on the Caryophyllaceæ. Professor Westwood exhibited drawings and read descriptions of various species of *Goliathi* from the Zambesi. Mr. Wilson, of Adelaide, communicated further Notes on the Buprestidæ of South Australia.

July.—Among the exhibitions were a collection of Lepidoptera from Mexico, by Mr. E. Saunders; of examples of *Dicranocephalus Wallichii*, from Northern India, and of *D. Bowringii*, from Southern China, by Mr. Stevens. Mr. Bond also exhibited a specimen *Dianthœcia cæsia* recently taken in the Isle of Man. Mr. Pascoe called the attention of the meeting to a paper by Mr. A. Müller, in the 'Zoologist,' respecting the cylindrical holes formed by insects alighting on the snow in the Higher Alps, and confirming the observations made by him (Mr. Pascoe) at a former meeting. Von Tschudi, in his 'Thierleben der Alpenwelt,' has stated that some of these holes attain a depth of two feet, and that the insects alighting on the snow do so apparently for the purpose of enjoying the oxygen which is *supposed* to be set free during the thawing of the snow. The Rev. Douglas Timmins communicated some notes on the larvæ of *Charaxes Jasius* and *Melitæa provincialis*.

August.—Collections of insects of all orders were exhibited by Mr. Stevens, from Madagascar, formed by Mr. Gerrard; and from Bahia, formed by Mr. Read. A collection of the cases of Caddis-flies from various parts of Europe were exhibited by Mr. McLachlan. Mr. Janson exhibited a pair of the rare *Velleius dilatatus*, found in the nests of the Goat-moth in the New Forest. Professor Westwood read an account of the ravages recently committed by locusts in Algeria, apparently one of the most destructive visits of those insects ever recorded.

VI. GEOLOGY AND PALÆONTOLOGY.

(Including the Proceedings of the Geological Society.)

The most important geological event of the past quarter is, no doubt, the publication of the third volume of the 'Memoirs of the Geological Survey of Great Britain,' consisting entirely of Professor Ramsay's long-promised work on 'The Geology of North Wales.' The descriptions of the fossils have been drawn up by Mr. Salter,

and their illustration by Mr. Bone leaves nothing to be desired on that score.

It is difficult to give in a short notice an adequate idea of the contents of such a work; it must therefore suffice to say that it consists chiefly of a detailed description of the Silurian rocks of North Wales, given in such a manner "that any one may ascertain the structure of any minor area in which he may be interested." We shall therefore endeavour to cull only a few opinions and statements of the author, which may be of general interest.

Of all subjects, perhaps that of breaks and unconformity is the one which Professor Ramsay has most successfully treated, not only in this work, but elsewhere. As regards the Lower Silurian rocks, there is no sign of unconformity between the Cambrian and the overlying Lingula-flags. The Tremadoc slates, which are extremely local in their occurrence, and the fossils of which have an aspect of their own, though more like those of the Lingula-flags than of the overlying strata, are probably unconformable on the former. The Llandeilo-flags succeed the Tremadoc slates, and there seems good reason to suspect an unconformity here also; but between the Llandeilo-flags and the beds above (Bala or Caradoc) there is no sign of unconformity; nor has any been proved to exist between the Caradoc strata and the Lower Llandovery above. Here the Lower Silurian series ends.

The Upper Silurian begins with the Upper Llandovery beds, which are found reposing indifferently and unconformably on any of the Lower Silurian deposits. This line of division, therefore, seems coincident with a natural break; indeed, Professor Ramsay states that before the Upper Llandovery beds were formed, all the lower members of the Silurian series had been disturbed and planed across by denudation. The Tarannon Shale, which comes next, is sometimes conformable to the Upper Llandovery, but sometimes overlaps it, and reposes unconformably on older strata; but the Wenlock and Ludlow beds above are in conformable succession to it.

Professor Ramsay's opinion of the signification of these later unconformities is thus given:—"The strata that lie between the top of the Caradoc, or Bala beds, and the base of the Wenlock Shale, were formed during a period of frequent oscillation of the relative level of the land to the sea. This oscillation succeeded the long and continuous deposition of the Bala beds, and preceded the formation of the Wenlock and Ludlow strata. The Lower and Upper Llandovery beds and the Tarannon shale belong, in fact, to a middle portion of the Silurian epoch only. Three fragments of this episode have alone been preserved, and while the oldest, that of the Lower Llandovery beds, is somewhat closely connected with the Lower Silurian period, the remaining two are more nearly related to the Upper Silurian age."

The object of the memoir is to elucidate these phenomena as far as they apply to North Wales, and as such it is a very welcome and useful addition to our knowledge of British Geology.

The literature of *Eozoon* continues to increase with great rapidity, and in this Chronicle we shall have to notice three important contributions thereto. The first of these is 'On the Occurrence of *Eozoon* in the Primary Rocks (Urgebirge) of Eastern Bavaria,'* by Dr. Gümbel, and its importance consists, not so much in its being the record of the occurrence of *Eozoon* in the Laurentian gneiss of Bavaria, as in its containing the description of a new form of that fossil (to use a negative term), which is considered by the author to constitute a new species, and for which he proposes the name *Eozoon Bavaricum*. This new species occurs at a much higher horizon than the original *Eozoon Canadense*, as will be seen by the following table of the Bavarian deposits, given in descending order :—

1. Hercynian Clay-slate with *Eozoon Bavaricum* .	Cambrian ? or Huronian ?
2. Hercynian Mica-schist	Upper Laurentian.
3. Hercynian gneiss, with *Eozoon Canadense* . .	Lower Laurentian.
3. Bojic gneiss	

Now, if the characters of *Eozoon Bavaricum* are really constant, and of specific value, the fact of there being known two recognizably distinct species of the genus adds enormously to the chances of both forms being of organic origin, the more so as the structural differences are associated with an immense difference in age. Moreover, Dr. Carpenter, in a postscript to a paper which we shall presently notice under the head of "Proceedings of the Geological Society," has recognized the similarity of the characteristic structures of the Bavarian *Eozoon* to those of the Eozoon of Connemara, which occurs in a still newer rock, namely, Lower Silurian. We may therefore quote an editorial note appended to an abstract of Dr. Gümbel's paper in the 'Quarterly Journal of the Geological Society,'† which is as follows:—"This observation is of considerable interest when viewed in connection with the relative geological age of certain Eozoonal rocks, more especially the probable Cambrian date of *Eozoon Bavaricum*, the Lower Silurian position of the Connemara serpentine, and the Laurentian age of *Eozoon Canadense*." At the same time it does not appear that Dr. Carpenter has expressed any opinion as to the specific distinctness of *Eozoon Bavaricum* from *Eozoon Canadense*.

The characters which are more especially relied on as distinctive are (1) the much smaller size of the individual structures in the

* Sitzungsberichte der Königl. Akad. der Wissenschaften in München. 1866. I. Heft 1.

† No. 87. Part 2 ; Miscellaneous, p. 24.

new species, and (2) the greater development of the irregular or "acervuline" portion.

In discussions as to the organic origin of *Eozoon*, it is, of course, desirable to bring forward as much collateral evidence as possible. Dr. Gümbel therefore cites several facts which he interprets to be indications of other organisms, the contemporaries of *Eozoon*. Especial stress is laid on the occurrence of graphite in the Hercynian gneiss of Bavaria and the Danube, and of beds of limestone in various localities; these the author believes to be the result of organic agencies, and although many geologists may agree with the conclusion, there are not a few, especially among mineralogists, who will decline to accept it. Dr. Gümbel, however, figures some tubular and reticulated bodies which certainly have a very organic appearance, but must be extremely minute.

The occurrence of *Eozoon* in Ophicalcite (serpentinous limestone) now appears to be very general, although the determinations do not always rest on very sufficient data; but it seems remarkable that this is the only kind of rock which is yet known to have yielded it; and those who disbelieve in the organic origin of the fossil have not failed to use this as a powerful argument in support of their views.

For many years the great "Diluvial" plain of Northern Germany has been literally harried by Prussian geologists in searching for fossils which might assist in solving the problem of the mode of its formation. Until the last two years, however, only fresh-water fossils had been found, in the region between the Elbe and the Oder, and particularly in the Potsdam district. Consequently, although it was difficult to believe that this great plain was of other than marine origin, yet the absence of marine fossils over the whole area was a fact of so much importance that a contrary conclusion seemed almost inevitable. In 1864, Dr. Ferd. Roemer recorded the discovery of *Cardium edule* and *Buccinum reticulatum* in the "Diluvial" deposits of the neighbourhood of Bromberg,* and justly considered it of great importance as being the "commencement of the discovery of the *hitherto quite unknown* marine fauna of the North German Diluvium." In the last number of the same 'Zeitschrift'† there is an account by Herr G. Berendt of the occurrence of these and three other species in West Prussia. The additional species are *Tellina solidula*, Lam., *Cerithium lima*, Brug. (*C. reticulatum*, Lov.), and a *Venus* which always occurs in fragments, but which appears to correspond with *V. pullastra*, Mont. The *Cardium* and the *Tellina* live now in the Baltic; the *Buccinum* has not been observed nearer than Kiel, but abounds on the shores of the North Sea, to which belong exclusively the *Venus*

* 'Zeitschr. der deutschen geol. Gesellschaft,' vol. xvi., p. 611.
† Vol. xviii. Heft. 1. p. 174.

and the *Cerithium*, which, however, are the most rare in the Diluvial deposits. All the species have thicker shells than their recent relatives, indicating, Mr. Berendt thinks, a salter sea than the Baltic of the present day. These facts are not very numerous absolutely, but relatively they form an immense addition to our knowledge of the fauna of the North German Diluvial Ocean.

M. Dupont has published, in the 'Bulletins of the Royal Academy of Sciences of Belgium,' the results of his explorations of the Caves* and Quaternary deposits† of the valleys of the Lesse and the Meuse. Along the course of the Lesse he discovered fourteen caves, of which we may take that of Chaleux as the type, and as being of most interest. This cave is shown to have been inhabited by man during three successive periods; and its exploration has yielded more than 30,000 worked flints, with numerous bones of Reindeer, Goat, Ox, Horse, Boar, Brown Bear, Fox, Badger, Polecat, Hare, and Water-rat. Most of these animals are supposed to have served as food for man, *especially the Horse*. Many human bones have also been discovered, and the condition of some of them has led to the inference that the ancient inhabitants of the caves were cannibals. The cave of Furfooz is supposed to have been used as a cemetery during a period anterior to the deposition of the Loess; and bones of the Brown Bear, Reindeer, Chamois, Beaver, Horse, &c., many of them fractured and burnt, are thought to represent the remains of a feast. The Quaternary beds also belong to three periods, namely, the upper stage with *Cervus tarandus;* the middle stage with *Ursus spelæus;* and the lower stage with *Elephas primigenius*. Rough-worked flints were found below the Loess, and polished ones above it,—a fact which confirms the observations of M. Malaise at Spiennes.

The 'Geological Magazine' for the quarter has been well filled with interesting matter, chiefly in relation to Denudation. We may especially draw attention to Mr. G. P. Scrope's articles in the June and July numbers, "On the Origin of Hills and Valleys," and "On the Terraces of the Chalk Downs." The object of the first paper is to counteract the tendency which the author fears exists in the minds of certain geologists, to ignore the action of subterranean force in helping to produce the present "form of the ground." Professor Jukes, he thinks, falls into this error when he speaks of "the action of internal forces" as "having no direct effect on the external features of the ground," except in the case of volcanic cones and craters. It was easy to see that Professor Jukes would reply that he fully acknowledged the *indirect* effect of subterranean forces, but that other causes had so modified the features which they had produced, that on the true "form of the ground" they had left little or no trace. The difference in opinion between these two

* Vol. xx., 1865, p. 824. † Vol. xxi., 1866, p. 366.

eminent men seems to be merely the difference in the meaning which they habitually attach to the expression "form of the ground." Mr. Geikie's paper "On Traces of Permian Volcanoes in Scotland" will be read with interest by those who remember his article in the last number of this Journal, and students of fossil botany will be pleased with the admirable paper "On Araucarian Cones" by Mr. Carruthers.

The July number opens with a description of an ancient coast-line in North Wales from the pen of a lady-geologist—Miss Eyton. It also contain's Mr. Scrope's second paper, in which he shows that Mr. Mackintosh had mistaken the terraces (called linchets or balks) worn out of the chalk and oolite hill-sides for sea-beaches! Mr. Scrope says of this notion, "I venture to say that a more preposterous idea has seldom been started for the confusion of geologists." But we think it will confuse very few, especially after Mr. Scrope's able description of the manner in which the linchets really are formed; and the test of their composition, which everyone may apply for himself. If they were sea-beaches they would be composed of sand and shingle; but in reality they consist of "wash" from the beds above. The other articles in this number are "On some Sarsens found in the Gravel near Southampton," by Lieut.-Col. W. T. Nicholls; "On some Polyzoa from the London Clay at Highgate," by Mr. G. Busk; and "On the Rock of the Cambridge Greensand," by Mr. Harry Seeley. Those interested in the "Denudation" question will find Mr. Jukes's letter, to which we have already referred, well worthy of a careful perusal.

The August number contains the first portion of a translation of Dr. Lindström's important memoir on operculated corals; but we shall reserve our remarks upon it until after the whole has been published, merely observing that the editor has conferred a real boon on palæontologists ignorant of Swedish. In a paper "On the Structure of Valleys in Essex," Mr. Searles Wood, jun., endeavours to prove that the valleys of the Blackwater and the Crouch have been formed by flexures produced from lateral pressure exerted from a centre or focus of earthquake disturbance under the Boulder-clay sea, "which flexures, by imparting direction to the denudation, had become deepened and strongly marked by the action of denudation proportionately to the extent to which they had undergone that process." The succeeding changes were of a somewhat complicated character, which it is necessary to read the paper to understand. In a short note "On the Disintegration of a Chalk Cliff," the Rev. Osmond Fisher most ingeniously shows that the profile of the solid chalk behind the talus formed by the disintegration of the upper portion of the cliff would be that of a semi-parabola, whose vertex is at the base of the original cliff. This number of the Magazine also contains two other papers on

Denudation, which are useful contributions as records of facts; their titles are: (1) "Ancient Sea-margins in the Counties Clare and Galway," by Mr. G. H. Kinahan; and (2) "On Watersheds," by Mr. G. Maw.

The 'Athenæum' records the discovery, by the Rev. W. Fox, of a Wealden Dinosaur of a new type, "its backbone being hollow, smooth, and compact, like a reed." It has been named *Calamospondylus Oweni* by its discoverer.

Proceedings of the Geological Society.

The very suggestive number of the 'Quarterly Journal' which we have this quarter to notice contains so many papers, on such a variety of subjects, that we must group those on kindred matters of general interest, and unwillingly pass over the rest.

The first two papers relate to *Eozoon*, so they may be naturally discussed together. The first of them, by Messrs. King and Rowney, is an endeavour to prove that the "Eozoonal" structures are the result of inorganic agencies; and the second, by Dr. Carpenter, is a supplement to his former papers on the Structure of Eozoon (in the same and other journals), viewed as an organic fossil.

In noticing the papers by Sir Wm. Logan, Drs. Dawson, Carpenter, and Sterry Hunt,* we made our readers acquainted with the chief features in the structures characteristic of *Eozoon*; we shall therefore consider them already understood, in a general way. Of these structures Dr. Carpenter relies chiefly upon the "asbestiform layer" or "proper wall" of the chambers, as especially demonstrating the organic nature of the fossil. According to him this is a calcareous band nearly surrounding the chambers, and perforated, during the life of the animal, by numberless tubules forming the passages for the pseudopodia. In its present mineral condition these tubules are seen to be filled with a siliceous mineral, while the calcareous matrix remains unaltered. The structure is thus preserved, and is described by Dr. Carpenter as exactly corresponding with that observed in the chamber-walls of recent Nummulites.

Messrs. King and Rowney, however, interpret this structure quite differently. They say that these "chamber-walls" are merely layers of Chrysotile,—a finely fibrous variety of Serpentine,—and they advance several facts in support of their view, of which we must be content to mention a few. They assert, for instance, that the "asbestiform" character of this layer is not constant, that it is sometimes uniformly and finely fibrous, but often composed of bundles of alternately coarse and fine fibres, while specimens occur

* 'Quarterly Journal of Science,' No. 6, April, 1865: "Chronicle of Geology."

in which two distinct "asbestiform layers" are seen superimposed on one another, and again in which the fibres are in some places parallel and in others divergent. They also raise a much more important issue: they say that the fibres are indefinitely fibrous, in other words, that each fibre, when examined with as high a power as is practicable, is resolved into fibres, each similar to what the original fibre itself appears to be under a lower power. They therefore consider this "asbestiform" layer to be of inorganic origin, and composed of chrysotile or some similar mineral.

Messrs. King and Rowney meet Dr. Carpenter on other grounds, without, in some cases, knowing that the points had been raised by the latter naturalist. But it would be tedious to mention all the structures which are differently described by the advocates of the opposite views, so we refer those interested in the subject to the papers themselves.

Treating the question geologically, Messrs. King and Rowney state that they have observed the same structures in serpentinous limestone of Laurentian, probably Cambrian, Lower Silurian (Connemara), possibly Devonian, and certainly Liassic (Skye) age, and they ask how this fact can be reconciled with its organic origin? The answer to this question might not be difficult; but we must confess that the remarkable fact of Eozoonal structures being found only in serpentinous limestones, and not in pure limestones, to which Messrs. King and Rowney also draw attention, is a far greater anomaly. According to Dr. Carpenter, however, Dr. Dawson has at last succeeded in detecting Eozoon in pure limestone.

Whichever way this question of the origin of *Eozoon* may ultimately be solved, we cannot help thinking that Messrs. King and Rowney's paper will have done a great deal to extend our knowledge of the structure of the fossil, and to permanently enhance their own reputation.

In a paper "On the Kainozoic Formations of Belgium," Mr. Godwin-Austen disputes the truth of the distinction which has been drawn between the subdivisions of the Belgian crag, and propounds the view that although they may have been produced "under slightly differing conditions, and in sequence, yet in the horizontal sections they replace one another." He also endeavours to show the inapplicability of percentage calculations as a means of determining the relative ages of these deposits, on the ground that while the fossils of the lower, or Diestien, beds, are proper to them, those of the upper, or Scaldisien, beds, are wholly extraneous, belonging to all regions of depth and all periods of the crag-formation. The conclusion is therefore inevitable that although the Diestien fossils may enable us to infer the condition of that part of the crag sea at a particular time, the Scaldisien fossils are no guide whatever in geological chronology. Mr. Godwin-Austen

also discusses several collateral questions, which we have not space to notice.

There are three papers on Post-pliocene Geology, namely:—

1. On the Formation of Lake-basins in New Zealand, by Mr. W. T. Locke-Travers.

2. On the Occurrence of dead Littoral Shells in the Bed of the German Ocean, forty miles from the coast of Aberdeen, by Mr. Robert Dawson.

3. On the Glacial Phenomena of Caithness, by Mr. T. F. Jamieson.

The third paper is by far the most important, as in it Mr. Jamieson shows that the glacial phenomena of Caithness differ remarkably from those observed in the midland region of Scotland, especially in the direction of the glacial markings, which point with great persistence from N.W. to S.E., or thereabouts; that is to say, from the open sea towards the interior instead of *vice versâ*. The author is therefore of opinion that the glaciation of the Caithness rocks has been produced by a movement of ice from an external region to the north-west; and from the abundance of marine shells in the drift it is probable that it was accumulated by the agency of marine ice. In these respects the traces of glacial action present a very strong contrast to those observed in central Scotland, as will be seen by a reference to former Chronicles.

The distinction is further borne out by the absence from Caithness of tranquilly deposited glacial-marine beds, of valley gravel, and of moraines and gravel hillocks. The area over which these peculiarities extend has not yet been determined, nor has the relative age of the shell-bearing boulder-clay; but it is probable that this is more recent than the true boulder-clay of central Scotland.

Mr. Locke-Travers's paper is occupied with a statement of facts tending to show that Dr. Haast's views of the formation of the New Zealand lake-basins are not borne out by actual phenomena; and Mr. Dawson's note is a record of the remarkable fact stated in the title.

The last paper in the Journal, entitled "On the Carboniferous Slate (or Devonian Rocks) and the Old Red Sandstone of South Ireland and North Devon," by Mr. J. B. Jukes, is of extreme interest to British geologists from its containing a new interpretation of the rocks of Devonshire; we must therefore devote the rest of this Chronicle to its consideration.

Geologists have hitherto considered that the strata of North Devon belong to the "Devonian Rocks," or marine equivalent of the Old Red Sandstone, and that in proceeding from Lynton to Barnstaple successively higher portions of the series were reached, there being a conformable dip southwards for the whole of the distance. In the south-west of Ireland there is a different set of

rocks from what have hitherto been supposed to exist in North Devon. There a formation known as the Carboniferous Slate occurs, reposing conformably on the Old Red Sandstone, and itself as conformably overlain by Coal-measures. In some districts Carboniferous Limestone occurs above the Carboniferous Slate, but then the latter is much thinner than when the former is absent; and, generally, when one of these two formations is most developed the other is either entirely absent or very thin, so that a general section may be drawn, having at one end Carboniferous Slate reposing on Old Red Sandstone, at the other Carboniferous Limestone on the same base, and in the centre a thinner development of both Carboniferous Limestone and Carboniferous Slate, the latter (being the lower rock) reposing as before on Old Red Sandstone.

Now, in this paper Mr. Jukes endeavours to show that the Devonian rocks of North Devon are the same, stratigraphically and lithologically, as the Carboniferous Slate of the south-west of Ireland; and that, instead of there being a conformable and uninterrupted succession of rocks from Lynton to Barnstaple, the series is repeated, owing either to a reversed anticlinal, or (what he thinks more probable) a great east and west fault running through the centre of North Devon, and having a downthrow to the north. At any rate, he considers that the rocks of Baggy and Marwood are the same as those of Lynton, and he suggests the only two possible modes of explaining the circumstance, seeing that the dip of the beds is, to all appearance, persistently south.

VII. MINING, MINERALOGY, AND METALLURGY.

Mining.

The condition of British mining is far from promising. The continued low prices of copper and tin press very heavily upon our mines, which are now, in nearly all cases, worked to great depths, and necessarily at heavy costs. The wages of the miners in Cornwall and Devonshire are reduced, and as there is but little prospect of improvement for some time to come, emigration is taking place to an unusual degree. This is much to be regretted, as the ablest men are those who emigrate, and we can ill afford to lose this class of labourers. The 'Mineral Statistics' recently published put us in possession of the results of our mining operations during 1865. Out of 619 mines which have been recently in activity in Cornwall and Devonshire, we find that 238 have suspended operations, and we learn that several others, and unfortunately some of those mines employing the largest numbers of people, are to be closed shortly.

The premonitions conveyed by these unfortunate results cast a gloom over all mining operations; but, unfortunately, those interested in the mines cannot be persuaded to adopt the only step by which they may mitigate the evil under which they groan. At present the supply of tin and copper ores is beyond the requirements of the smelters, and therefore they purchase only at the lowest prices. These prices are not renumerative, consequently nearly all the mines are now working at a loss. Yet they struggle on, because the managers and the mines would be thrown upon the cold mercies of the world if the works were abandoned. Thus, our tin mines, especially, are producing far more tin than is wanted, and a glutted market necessarily compels low prices. This state of things cannot long continue: slowly, reluctantly, one mine after another is suspended, and real distress is staring a most industrious population in the face. Our young and able miners are emigrating; our older men suffer without murmuring, and hope for better days. (Since the above was written there has been an advance in the price of tin ore to the extent of 7*l.* 10*s.* the ton, and a small advance upon copper. The natural result of this is to induce a more cheerful spirit. It is also satisfactory to note that the miners instead of emigrating are now seeking and finding employment in the colliery and other districts.)

The quantity of tin ore raised in 1865 was 15,686 tons, from which 10,039 tons of metallic tin were obtained; within the same period we imported, principally from the Dutch settlements in the Eastern Archipelago, 5,699 tons of tin and 639 tons of tin ore and regulus.

There were 203 copper mines in the United Kingdom sending copper ore to market during 1865. These produced 198,298 tons of ore, from which were smelted 11,888 tons of copper of the value of 1,134,644*l.* It appears, however, from a table given in the 'Mineral Statistics,' that the price at which the ore sells, and the produce of the ores raised, have for many years steadily declined. There has been, for some considerable time, no important discovery of any new deposits of copper, we may therefore infer that copper mining in these islands has seen its best days. Our importations of copper in 1865 were very large. From our Colonies and Foreign parts we received 82,562 tons of copper ore, 39,686 tons of copper regulus, and 7,026 tons of copper in bricks and pigs. If we were to draw our conclusions from the statements given of the public sales of copper ores, we should naturally say that the imports were steadily declining. The Foreign and Colonial ores sold in 1856 being 28,997 tons, against 16,332 sold in 1865, but it must not be forgotten that 66,230 tons of copper ore passed into the hands of the smelters by private contract purchases. This is, in many respects, an unfortunate state of things; the only benefit

arising from this system, to balance numerous disadvantages, being to establish more securely the monopoly of the copper smelters.

The British isles produced of lead ore 90,452 tons, the value of which was 1,153,154*l.*; from this was obtained 67,181 tons of lead and 724,856 ounces of silver, the value of the lead being 1,433,161*l.*, and that of the silver being 199,335*l.*

Passing from silver to gold, we find that the Welsh mountains produced in 1865 1,664 ounces and 11 dwts. of gold. It would be interesting to know at what cost this gold was obtained. Of zinc ores we appear to have produced 17,842 tons, and of iron pyrites (*sulphur ores*) 114,195 tons.

By far the most important of our mineral products remain to be noticed. Our coal and our iron must, at present—view them in whatever light we may—be regarded as the mainstays of our manufactures and of our commerce. In 1865 we had 3,256 collieries at work, and from them we drew the enormous quantity of 98,150,587 tons, of this we exported 9,170,477 tons, retaining 88,980,110 for home consumption. Of this it appears that 14,457,762 tons were used in making 4,819,254 tons of pig iron, and 14,325,390 tons employed in converting this into merchant iron. Our purpose in this place is merely to chronicle facts as they arise; we could have commented on the appointment of the Royal Commission to inquire into the duration of our coal fields, and other matters connected with this subject, had they not been treated fully in another division of our Journal.*

It may be incidentally stated that we learn the labours of the Royal Commission have been divided amongst several committees, who are to consider:—

1. The waste of coal in getting.
2. The waste of coal in consumption.
3. The depth to which collieries may be worked and ventilated.
4. The existence of coal under the Eastern Counties.
5. The statistics of produce—trade and manufacture.

The extension of our coal fields being committed to the charge of the Geological Survey.

The total value of our mineral productions is thus given in the 'Mineral Statistics':—

Total value of Minerals, 32,359,105*l.*

The total value of the Metals obtained from the metalliferous ores of the United Kingdom being . . .	£15,773,287
The value of the Coal raised . . .	24,537,646
Earthy Minerals, not including Clay or Building Stones	1,434,496
	£41,745,429

* "Our Coal Resources and our Prosperity," Art. I.

being the money-worth of the productions drawn from our rocks. To this must now be added the mineral oils produced in this country from the bituminous shales and cannel coal. The value of those mineral oils has not been given by Mr. R. Hunt, but we have every reason for believing that it does not fall short of three millions sterling. If therefore to the above we add this and the estimated value of our clays, bricks, slates, and building stones, we cannot estimate the mineral wealth of the United Kingdom at the present time at less than fifty millions sterling.

The necessity of working our collieries with economy is forcing —more and more—upon the attention of our coal proprietors the application of machinery for cutting coal. We have already described several of those machines; some of which are, we believe, doing their work effectively. We cannot afford space in this Journal for any long descriptions of machines, howsoever ingenious they may be, which have not received the test of a sufficiently long experience in actual working, to determine their merits.

Our attention has been called to a new hydraulic coal-cutting machine manufactured by Messrs. Carrett, Marshall, and Co., of Leeds. The machine is described as automatic, of three-horse power, and cutting at the rate of fifteen yards per hour, four feet into or under the coal, and at any height or angle, and at once going over. It uses in this work thirty gallons of water, making fifteen strokes a minute at a pressure of about 300 lbs., the cutting tools displacing only three inches of the coal so undercut. There are doubtless many advantages in the use of hydraulic power rather than that of air. In one case the power can be conveyed without loss; in the other the loss of force is great. This machine was highly spoken of at the recent Meeting of the British Association.

Messrs. Pigott and Farrar, of Barnsley, are said to have made some great improvements in a machine for pumping or compressing air for working coal-cutting machines, or for propelling engines of any kind used in a colliery. We also hear of a new coal-cutting machine, the joint invention of Mr. Gillett, mechanical engineer, and Mr. E. Beecher, the colliery engineer at the Thorncliff and Chapeltown Collieries. When these machines have had a sufficient trial we may again return to a consideration of them.

Mineralogy.

M. Pisani having received a black Spinelle from Haute-Loire, through the attention of M. Bertrand de Lorn, has submitted it to careful examination, and communicated the results to the Academy of Sciences of Paris, through M. Ste. Claire-Deville. This black Spinelle has been found principally in the Haute-Loire, but it has been met with in Cantal and the Puy-de-Dome. It is found in the

igneous rocks of the Auvergne, spread in black octohedral crystals in the fissures and small cavities. It is also found in the detritus from the disintegration of these rock masses.

The analysis of this mineral is, as given by M. Pisani:—

Alumina	59·06
Ferric Oxide . . .	10·72
Ferrous Oxide . . .	13·60
Magnesia	17·20

which gives the formulæ $MgOFeO$, $Al^2O^3Fe^2O^3$.

This composition is that of a true Pleonaste, which is a black variety of the Iron and Magnesia Spinelle. But this variety is rendered remarkable by its crystalline form—an octohedral pyramid —which has not until now been recognized in any of the Spinelles.

Some remarkable discoveries of Native Lead have been made lately in Victoria, Australia. It is found associated with gold and oxide of iron in the gold drifts, under the basalt, and in the neighbouring veins containing Galena. Specimens have been forwarded to Mr. R. Brough Smyth, the Inspector of Mines at Melbourne. The first samples were from a "lead" at Mount Greenock, near Talbot, where they are said to be numerous. The second series of specimens came from the main "lead" at Aorca, where they are obtained from nearly every part of the "wash dirt." Mr. R. Brough Smyth informs us that, when carefully analyzed, he intends to forward the specimens, with a description, to the Geological Society.

From one of the journals published at Auckland, we learn of a valuable discovery of Bismuth in New Zealand. This metal is associated with copper, and by some novel process, it is said, the copper and the bismuth are economically separated from each other.

The production of the diamond by artificial means is once more attracting attention. M. de Chancourtois, in a paper read before the Academy of Sciences of Paris, announces that he has obtained, in a little more than twenty years, small crystals of diamond, by very slowly decomposing sulphide of carbon, by tin excited by a very weak electrical current. M. Elie de Beaumont has made a communication on the subject to the Academy.

Professor A. H. Church communicates to the 'Chemical News' the discovery of *chloropal* abundantly in a quarry close to the old tin mine of Carclase. "The *chloropal* occurs with Fluor in the fissures of the granite, and resembles that variety of chloropal which has been termed "gramenite," from Menzenberg near Bonn."

In 'L'Institut' for June is an interesting paper by M. Goebel, "Researches on the Carnalite, and upon the Red Coloration of certain Minerals." This paper was read before the Academy of Sciences of St. Petersburg. We must refer our readers to the original,

XUM

as it will not bear abstracting. Professor Shephard, in 'Silliman's Journal,' vol. xl., p. 110, announced the discovery of a new mineral *Syhedrite*, and L. S. Inglestrom, in the 'Journal fur Praktische Chemie,' vol. xcvii., writes of *Kondro-Arsenite* as a new mineral, but this requires confirmation.

Metallurgy.

Mr. C. Cochrane, of Dudley, has patented a process for separating dust from the gases evolved from blast furnaces. This in many cases is so great as to considerably interfere with the economical application of those gases. Mr. C. Cochrane proposes to construct a cylindrical chamber into which the gases pass, entering at the upper end, and descending and passing off at the lower end, of such chamber. In this chamber are numbers of parallel partitions, so arranged as to come below the open spaces in the partitions above. By passing through those partitions, the gases are filtered of the dust they hold suspended. We fear some difficulty may be experienced in getting the gases to pass against the action of gravity.

At the present time few things are attracting more attention than the use of anthracite in the manufacture of iron. In America for a long time this fuel has been employed, but not, as it appears, with anything like the economy which has been recently obtained by Mr. Samuel Blackwell, of the Yniscedwin iron works, in South Wales. For some weeks past the results upon a new blast furnace, constructed after many experiments, have been the production of 1 ton of pig iron with 18 cwt. of coal in the furnace. This is, we believe, the greatest economy which has as yet been effected in the make of iron, and this anthracite iron is said to possess properties which render it peculiarly valuable for steel making.

Messrs. Vivian and Sons, of the Llandor smelting and alkali works, Swansea, appear to have been eminently successful in their application of the new furnaces—Gerstenhofer's patent—for the combustion of the sulphur, sublimed from the copper ores, and the conversion of it into sulphuric acid.

If this process is adopted at all the smelting works, Swansea will be relieved from the cloud of copper smoke which is ever hanging over it, and many thousands a-year will be saved by the conversion of the sulphur now wasted into an article which is in extensive use in manufactures.

VIII. PHYSICS.

LIGHT.—Professor Roscoe, of Owens College, writes us that in the last number of our Journal, in an article on De la Rue and Celestial Photography, the author has unwittingly done him an injustice in attributing to him the claiming of a discovery which was already known. Referring to the statement as to the well-known difference between the intensity of light from the centre and from the border of the sun's disc, Dr. Roscoe writes, "What I believe to be original in my communication, is the *numerical determination* of the amount of a difference which has been long observed."

Dr. Memorsky and Professor Brucke, in a paper communicated to the Vienna Academy, describe diffuse daylight as strongly reddish, just as gas or lamplight is yellow. The only perfectly white light, they tell us, is the electric light from charcoal points. The light of burning magnesium, and the combustion of phosphorus in oxygen, they say are violet.

M. A. Bertin has examined the constitution of glacier ice by polarized light. He has found that the superficial part of the higher glaciers is composed of agglomerated snow; but lower down, where the water has sunk into the fissures and become frozen, crystallization and true ice are found.

Professor Bunsen has made a discovery in connection with the absorption-spectrum of Didymium which may prove of great theoretical importance. In a paper which he published in conjunction with Professor Bahr some time ago, it was shown that slight differences were observed in the absorption-spectrum of sulphate of didymium according as the light was allowed to pass through a crystal or through a solution of the salt. Since that time Professor Bunsen has found that the erbum and didymium spectrum undergo alteration if polarized light be employed and either the ordinary or the extraordinary ray be allowed to pass through the crystal. It has also been found that whilst, when spectroscopes with one prism and with a telescope of moderate power are employed, the spectrum of the various didymium compounds do not show any difference, yet most undoubted differences are noticed when more powerful instruments are used. These differences cannot, in our present complete state of ignorance of any general theory for the absorption of light in absorptive media, be connected with other phenomena. They remind one of the slight and gradual alterations in pitch which the notes from a vibrating elastic rod undergo when the rod is weighted, or of the change of tone which an organ-pipe exhibits when the tube is lengthened. These curious phenomena form the subject of a long paper by

Professor Bunsen, which appears in the September number of the 'Philosophical Magazine.'

HEAT.—According to some experiments made by M. Gripon on the conducting power of Mercury for heat, it appears that if the conducting power of silver = 100 that of mercury = 3·54. It stands therefore the last of the metals, and a little before marble or gas coke. The author mentions that in this case the conducting power for heat and for electricity is very different, the former being 3·54, and the latter 1·80.

Although scarcely coming under the heading of "Heat," yet as they point to a possible means of storing up heat and force for future use, we give here an abstract of Professor Graham's most remarkable discovery in dialysis. The Professor finds that atmospheric air drawn through films of caoutchouc leaves behind a large portion of its nitrogen. The septum has no porosity, and is really impervious to air as gas; but the india-rubber film is capable of liquifying the individual gases of which the air is composed, whilst the oxygen and nitrogen, in the liquid form, penetrate the substance of the membrane *unequally*, and appear on the other side, where they again become gaseous. The rubber film thus becomes a dialytic sieve for atmospheric air, and allows very constantly 41·6 per cent. of oxygen to pass through instead of the 21 per cent. usually present in air. This dialysed air rekindles wood burning without flame, and in many other respects can replace pure oxygen for laboratory and technical purposes.

ELECTRICITY.—The electro-chemical properties of Magnesium have been applied to a very useful purpose by M. Roussin. Hitherto, in the toxicological examinations for metals, zinc has been exclusively employed, but this metal, as met with in commerce, is always impure, and the employment of magnesium has now been proposed as a substitute. Magnesium has the double advantage of rapidly and completely precipitating poisonous metals, without the danger of introducing any other poisonous substance. Arsenic and antimony are not precipitated, but will be found in the gas disengaged and in the liquid remaining. The author destroys organic matter by the usual methods, concentrates the acid liquor, and then introduces ribbons of magnesium as long as any deposit is formed. This precipitate is washed and examined by the usual method for metals. If the operation be conducted in a Marsh's apparatus, the gases may at the same time be examined for arsenic and antimony. The magnesium now to be purchased, in the form of ribbon or wire, is almost perfectly pure, and its price is so moderate that this can be no hindrance to its general use in laboratories.

Some new electric batteries have been described by M. Mouthier.

In the first he uses sulphuric acid and iron. In a cylindrical vessel of iron he places a prism of carbon, and then pours in dilute sulphuric acid. The carbon and iron form the two poles. Two of such batteries are sufficient to cause the ordinary telegraphic bell to ring. The batteries are said to be cheap, inasmuch as the sulphate of iron produced may be used in another system, composed as follows:—In a cylindrical vessel containing a concentrated solution of protosulphate of iron, the author places a cylinder of zinc and a prism of carbon forming the two electrodes of the pile. The zinc dissolves, hydrogen is disengaged, and hydrated sesquioxide of iron precipitated. Two elements of this kind served for an electric bell for several months.

M. Zaliwski-Mikorski has announced to the French Academy that he finds smearing the zincs of a Bunsen's battery with grease will answer the same purpose as amalgamating them. The fact may be as he states, but certainly he is not very happy in his explanation when he says that the grease acts as a body rich in hydrogen; that is to say, as a combustible body.

IX. ZOOLOGY AND ANIMAL PHYSIOLOGY.

A Report of the Proceedings of the British Association at Nottingham in reference to the subjects of our Chronicle will be found elsewhere. The most remarkable feature in the Meeting in this regard was the advocacy of Darwinism by the President, Mr. Grove, —as part of the Law of Continuity then enunciated by him—and the general support which the theory of the Origin of Species by modification and descent received from the leading men of Section D.

We understand that it is proposed to hold an Anthropological Congress in Calcutta on a very extensive scale. The Government is intending to inaugurate an Exhibition of Arts and Manufactures in that city in 1869 and the members of the Royal Asiatic Society conceive that this will be a suitable and valuable opportunity for an exhibition of living men of various races. Calcutta is itself a city peculiarly fitted for such a gathering: in addition to the great variety of the tribes of the continent, individuals of whom are abundant within its walls, Chinese, Malays, Andamanese, Singalese, Polynesians, and Australians are to be found amongst the shipping, and no doubt a large number will be attracted by the exhibition. The Council of the Asiatic Society have accordingly addressed the Indian Government for assistance in carrying out their scheme, with a partial success, and there is every reason to believe that such an exhibition of men as was never before witnessed will be visible in

Calcutta in two years' time. It is intended to invite delegates from all the chief Scientific Societies of Europe, to assist in comparing, photographing, examining, and otherwise utilizing the collection of men when once assembled.

In our last Chronicle we noticed M. Paul Broca's researches on the site of the faculty of speech. We have now to record some observations by Dr. Gairdner, of Glasgow, confirmatory of M. Broca's conclusions, and touching on the question of the connection between the power of using words in speech or writing and the power of using them in thought. Dr. Gairdner describes several cases of the *Aphasic* state—Aphasia being the term introduced by M. Trousseau for that condition of inability to use words generally attacking the patient suddenly—which has been by others called Aphemia and Alalia. In these cases the persons frequently have the power of uttering an oath or ejaculation, or repeating what they have just heard, but otherwise are dumb. In one case the power of writing was tested, and the patient was found able to copy his name, but was utterly unable to write it from dictation. In these cases paralysis of the right side of the body is nearly always present, and diseases of the whole cerebrum, or of the left frontal portion only. A case observed by Dr. Sanders is particularly interesting. Aphasia had attacked a man who was otherwise quite intelligent. After some time he died; an examination of the brain was made, and disease was actually found only in the very part indicated by M. Broca's researches, *viz.* the external left-frontal convolution.

Dr. Gairdner discusses the question whether loss of intelligence necessarily accompanies Aphasia, and concludes that though such an effect need not occur immediately, yet the loss of the power of symbolizing thought by words must necessarily in time lead to this. M. Lordat maintains that in his own case he could think and arrange *ideas*, though he had lost the use of words. Dr. Gairdner thinks that such a power could not remain long. We have all heard, or perhaps known, what it is to think in a *foreign language*. The mere fact that people *do* this shows that the use of words as symbols is necessary in thought. The deaf and dumb have other symbols by which to think, not having been educated in the use of words. It is possible that some persons think *ideas* rather than words, but such thought can hardly extend to details. In the discussion on Dr. Gairdner's Essay, which was read to the Philosophical Society of Glasgow, Dr. Allen Thomson remarked, that the truth of M. Broca's observation was a death-blow to the assumptions of so-called phrenologists, since they placed the faculty of language over the eye, whereas the part of the brain indicated by M. Broca lay near the temporal fossa.

M. Marey, the able inventor of the Sphygmograph, has published an interesting and ingenious essay in Robins' 'Journal de

l'Anatomie,' entitled "Pictorial Studies (*études graphiques*) on the Nature of Muscular Contraction." The instrument used in these investigations is called a myograph, and consists of a sort of spring clamp by which the muscle is lightly grasped and so arranged that any variation in the tension of the arms of the clamp shall effect the continuity of a galvanic current. The variation in the galvanic current is made to exhibit itself in the movement of a pencil, by which the myogram is written, as in the sphygmograph. Dr. Marey considers that voluntary muscular contraction is a complex phenomenon, resulting from the fusion of a series of successive "agitations." A muscular agitation is the movement which one observes under the influence of a single electric or traumatic excitation directed on a nerve or a muscle. It is most necessary to distinguish between this phenomenon and *contraction*, of which it is only an element, in the same way that a vibration is one of the elements of a sound. The characters of these muscular agitations can be determined by the myograph, and are found to vary under the influence of fatigue. A definite number is necessary to produce contraction of the muscle, but the number varies according to the animal and to the condition of fatigue. Helmholtz considered that 32 agitations in the second were necessary for tetanization, that is, complete contraction; but M. Marey shows that in a bird 75 may be necessary, and in a tortoise only 4. He regards the systole of the heart as a single "agitation" (*secousse*).

Dr. Charlton Bastian in the last number of the 'Quarterly Journal of Microscopical Science,' has entered into a minute description of the curious little granular bodies occurring on the surface of the brain, first described by Antonius Pacchionius, and known as Pacchionian bodies. Much laxity and carelessness has hitherto existed in reference to these bodies. By Pacchionius they were called glands, but this soon proved to be incorrect, though their true structure was never demonstrated. Many authors regarded them as arising from the *pia mater* beneath the arachnoid. Dr. Bastian shows that these growths are invariably developments from the visceral arachnoid, and has demonstrated that they have a complete epithelial covering and a fibrous structure agreeing with that of the arachnoid. Dr. Bastian's conclusions were anticipated to some extent by Ludwig Meyer, in a recent number of 'Virchow's Archiv.,' but this does not detract from the value of his independent research.

The second volume issued by the Ray Society to its subscribers for the year 1866, is a series of translations from the Scandinavian languages of recent memoirs on the Cetacea, by W. H. Flower, F.R.S. The first is "On the Greenland Right Whale" (*Balæna mysticetus*), by D. F. Eschricht and J. Reinhardt, originally published in 1861. No other complete description of the osteology

of this most interesting animal exists, and hence the importance of the work. Mr. Flower further adds some notes on the skeleton lately acquired by the College of Surgeons. The second memoir is by the late Professor Eschricht "On the Species of Orca inhabiting the Northern Seas." He carefully decides on three species, instead of one only as had been supposed. The third memoir, on *Pseudorca crassidens*, is by Professor Reinhardt. He has given a careful and detailed description of the external and osteological characters of this remarkable form of Cetacean, hitherto only known by a skull exhumed from a fen in Lincolnshire, and therefore thought to have been long extinct. The sudden appearance of several individuals of this species on the coast of Denmark in 1862, shows how much may still be unknown of the Cetacean life, even in seas most frequented by civilized and observing man. The fourth memoir is by Professor Lilljeborg, "On the Scandinavian Cetacea." The most important novelties in it are the descriptions of two perfectly distinct species of large whales found in a subfossil state in Sweden.

The publication of a supplementary volume to Professor Hitchcock's great work "On the Ichnology of the Connecticut Valley" is of some interest. From various considerations adduced, such as the bird-like character of the foot markings, and the evidence that the individuals were quadrupeds, we must be fully prepared for the discovery of Reptilian Birds and bird-like reptiles, filling out the class Saurornia, lately proposed by Mr. Seeley to receive the Pterodactyls. Good evidence is now accumulating of many links between the reptile and bird, already considered as most closely related. We have a bird with teeth and a long tail and hooks on its wings, in the *Archæopteryx;* we have a reptile with wings and probably plumage in the *Pterodactyl;* and now it appears from the evidence of the sandstones of Connecticut, that there existed strange four-footed birds, the wings probably provided with feet at their extremities, also possessing long tails and covered with feathers.

In a late number of 'Wiegman's Archiv.,' Herr Elias Mecznikow describes some of his observations on the ciliated worms, or Turbellaria, in Heligoland. He has found that a very curious form, *Alaurina*, found by Busch at Malaga, and also by Claparede off Scotland, and considered by them as a larval form, is the representative of a distinct group among the Rhabdocœla, or straight-gutted Turbellarians. He met with similar forms in Heligoland: all were composed of four parts, of which the foremost was longest, the total length being only $1\frac{1}{2}$ millimetres. The anterior part was furnished with a tactile proboscis, as in the animals of Busch and Claparede, whilst a long seta existed at the posterior end, and the body, of a pale-citron colour, was covered with a dense coat of fine cilia. The nervous system was obscure; the mouth, situated on

the ventral surface, lead into a ciliated buccal cavity, which narrowed into a muscular pharynx; the intestine was straight and without any posterior orifice. On the two sides of the body were two very fine water-vascular stems. The genitalia were complete, This very interesting worm presents some analogies to the Cestoda, the jointed character of the body perhaps representing, as in that group, an animal colony.

We have to notice the Report of the Proceedings of the Bristol Naturalists' Society, from which it appears that this Society is in a very flourishing condition and doing much good work. Among the list of papers we notice particularly that of Dr. Henry Fripp "On the Eye of the Cepholopoda;" and that of Mr. A. Leipner "On the Asexual Reproduction of Cecidomya Larvæ."

We have also received the first annual Report of the North Staffordshire Naturalists' Field Club, which is a much younger society, and confines its exertions at present chiefly to excursions in the district. The President of this Society is Mr. James Bateman, F.R.S., while the Rev. S. T. Nevill, late of Magdalen College, Cambridge, is Treasurer. We may hope to chronicle important work done by this body of naturalists on some future occasion.

The Quekett Microscopical Club has issued its report for the past year, and numbers over a hundred members. The President for the ensuing year is Mr. Ernest Hart; the meetings take place once a month at University College.

Meanwhile the older and more scientific Microscopical Society of London is about to be incorporated as a chartered society, and members will enjoy the privilege of the use of the letters F.M.S. after their names.

At the late meeting at Nottingham a new half-yearly journal was announced, to be called 'The Journal of Anatomy and Physiology,' edited by Dr. Turner, of Edinburgh, Dr. Wright, of Dublin, Professor Newton, Professor Humphry, and Mr. Clarke, of Cambridge. Much may be expected from the high scientific characters of these gentlemen, and the enterprise of the publishers, Messrs. Macmillan. The journal is to appear twice a year, and to consist chiefly of original articles, to be largely illustrated by plates.

THE ASSOCIATION OF CERTIFICATED SCIENCE TEACHERS.

This Association, which was inaugurated at Birmingham in 1865, held its first Annual Meeting in Liverpool last July, and we are glad to find from the report forwarded to us by the Honorary Secretary, Mr. Mayer, F.C.S., of Glasgow, that it has met with the approval of the Committee of Council on Education.

The Association well merits the support of the State, and our new Ministry will do much towards attaining that popularity which is the legitimate ambition of all new Governments, by giving to it their best countenance.

At the Annual Meeting, presided over by Dr. E. Birkenhead, a Science teacher, the recently appointed Lecturer on Chemistry at the Liverpool Royal Infirmary School of Medicine, a number of useful resolutions were adopted, of which the following deserve special notice:—

1. That the Secretary should put himself in communication with publishers of text-books suitable for use in Science classes, requesting them to consider the propriety of granting such books on the most favourable terms possible to members of the Association, when they are ordered in quantities.

2. That, while regarding the Examiners in Geology and Physical Geography with all the respect that is due to their great eminence in their own special departments, the teachers interested in the examinations in those subjects in May last have some reason to regret that the examiners saw fit to draft such difficult examination papers as were given to the pupils, and to fix such a high standard, as the great percentage of failed candidates and the small number of first-class prizes awarded would seem to indicate.

3. That the Secretary should write to the Science and Art Department, and respectfully request:—i. That a careful revision be made of the syllabus contained in the 'Science Directory;' ii. That, as far as possible, each examiner shall name, after the syllabus of his own subject, the most suitable text-books to be used for that subject; iii. That the examination papers should be framed in accordance with the heads of subjects mentioned in the syllabus.

4. That the Council should recommend to the Secretary of the Science and Art Department, that certificates be awarded to all "passed" pupils, without any regard to the prizes at present given to first, second, and third class candidates.

We must confess that some of the questions asked by the Examiners have puzzled us not a little, and although the Examiner in Geography is no doubt entitled to the respect of the Science

teachers, we have grave doubts whether he understands the capacity of the class of persons (the industrial classes) for whom his examination papers are framed, or he would not ask them to tell him what is the latitude of the mouths of the four largest rivers in China! We should like to have the information ourselves, merely out of curiosity, for it would not be of much benefit to us if we possessed it.

The heads of the Science Department will do well to encourage the Science Teachers' Association, for the gentlemen who constitute it are of the people and among the people, and they combine with a large amount of scientific knowledge a thorough acquaintance with the wants of the masses. They are far better able to advise those who have the disposal of the public money than scientific men, however eminent they may be, who are absorbed in their theories and researches, and are from their very pursuits unable to adapt themselves to the requirements of those whom the Science and Art Department is intended to benefit. We recommend the Council of the Association to make it as accessible as they can to the teachers, many of whom are not wealthy, and cannot afford to lay out much money without a tangible return; but if the subscription be low enough (and we really see no reason why it should be more than nominal), it ought to be, and no doubt will be, joined by every Science teacher in the three kingdoms.

The next Annual Meeting is to be held in Manchester.

Quarterly List of Publications received for Review.

1. The Lake Dwellings of Switzerland and other Parts of Europe. By Dr. Ferdinand Keller, President of the Antiquarian Association of Zürich. Translated and arranged by John Edward Lee, F.S.A., F.G.S. 96 Plates. 420 pp. 8vo. *Longmans & Co.*

2. Tapeworms (Human Entozoa): their Sources, Nature, and Treatment. By T. Spencer Cobbold, M.D., F.R.S., Lecturer at the Middlesex Hospital. 90 pp. Fcap. 8vo. *Longmans & Co.*

3. Reliquiæ Aquitanicæ; being Contributions to the Archæology and Palæontology of Périgord and the adjoining Provinces of Southern France. By Edouard Lartet and Henry Christy. Part III. *From the Executors of the late Henry Christy, Esq.*

4. The Handbook of the Stars: containing the places of 1,500 Stars, from the first to the fifth magnitude, &c., &c. By Richard A. Proctor, B.A., F.R.A.S. Illustrated. *Longmans & Co.*

5. Cholera: What it is, and How to prevent it. By Edwin Lankester, M.D., F.R.S. *Routledge & Sons.*

6. Memoirs of the Geological Survey of Great Britain, and of the Museum of Practical Geology.—Mineral Statistics of the United Kingdom of Great Britain and Ireland for the year 1865. With an Appendix by Robert Hunt, F.R.S., Keeper of Mining Records. 315 pp. Royal 8vo. *Longmans & Co.*

7. Electricity. By Robert M. Ferguson, Ph.D., of the Edinburgh Institution. 148 Wood Engravings. 280 pp. Fcap. 8vo. *W. & R. Chambers.*

8. Vivisection: is it Necessary or Justifiable? Being two Prize Essays published by the Royal Society for the Prevention of Cruelty to Animals. 120 pp. Demy 8vo. *Hardwicke.*

9. A Dictionary of Science, Literature, and Art. Edited by the late W. T. Brande, D.C.L., F.R.S., and Rev. G. W. Cox, M.A. *Longmans & Co.*

10. Memoirs of the Geological Survey of Great Britain. The Geology of North Wales. By A. C. Ramsay, F.R.S., with Maps and Sections; and an Appendix on the Fossils, with Plates, by J. W. Salter, A.L.S., F.G.S. *Longmans & Co.*

PAMPHLETS, PERIODICALS, PROCEEDINGS OF SOCIETIES, &c.

On the Convolutions of the Human Cerebrum, topographically considered. By William Turner, M.B. Lond., F.R.S.E. *Edinburgh: Machlachlan & Stewart.*

Speech of H. Hussey Vivian, Esq., M P., F.G.S., On the Coal Question. (Delivered in the House of Commons, Tuesday, June 12, 1866.) *W. Ridgway.*

Statement by Mr. Ure on the Sanitary Scheme and Duties of the Medical Officers of Health. *Glasgow*, 1865.

Results under the last Bank Charter Act, 1864-6. By C. M. Willich. *Longmans & Co.*

Artisans' and Labourers' Dwellings Bill.

Sanitary Act, 1866.

Notes on the Foliation in the Gneiss and Schist of Yar-Connaught. By G. Henry Kinahan, Senior Geologist of the Geological Survey of Ireland. 20 pp. Demy 8vo. *From the Author.*

Reply to a Letter addressed to Malcolm Ross, Esq., President of the Manchester Chamber of Commerce. By John Dickenson, jun., Esq.; on the Subject of the Manchester Conference, January 24, 1866. By Robert Knight ('Times' of India). 13 pp. 8vo. *Johnson.*

American Journal of Conchology. Vol. I. Part 2.

A word on the Origin of Life. By James D. Dana.

On Cephalization. No. IV. By James D. Dana.

On the Future Water Supply of London. By Geo. Willoughby Hemans, C.E., and Richard Hassard, C.E. With Map. 32 pp. Demy 8vo. *Stanford.*

Address at the Anniversary Meeting of the Royal Geographical Society, 28th May, 1866. By Sir R. I. Murchison, Bart., K.C.B., &c., &c.

On Vitality. By Rev. H. H. Higgins, M.A. 19 pp. Demy 8vo. *Liverpool: Holden.*

Notes on the Cells of the Bee. By Jeffries Wyman, M.D., Hersey Professor of Anatomy in Harvard College. 16 pp. Royal 8vo. *From the Author.*

Chemical Addenda: Being a Brief Exposition of the Salient Features of Modern Chemistry. Designed as an Appendix to Elementary Text-books on the Science. By Rev. B. W. Gibsone, M.A., B. Sc. Lond., Lecturer in Chemistry at the City of London College. 20 pp. Fcap. 8vo. *J. H. Dutton.*

On the Application of Disinfectants in Arresting the Spread of the Cattle Plague and Cholera. Report to H.M. Commissioners. W Crookes, F.R.S. *Dutton, Wine Office Court.*

Further Observations on the Spectra of some of the Nebulæ, with a Mode of Determining the Brightness of these Bodies. By William Huggins, F.R.S.

A Discourse on Spectrum Analysis applied to the Heavenly Bodies. By W. Huggins, F.R.S., F.R.A.S. (British Association Lecture.)

Important on Cholera and the Public Health. By G. E. Waterton.

Cholera: Its Symptoms and Treatment. By A. O. Jones, M.D. *Jackson, Walford, & Co.*

The True and False Sciences: A Letter on Homœopathy. *Churchill & Sons.*

Report of the North Staffordshire Naturalists' Field Club. 1866.

Annual Report of the Board of Regents of the Smithsonian Institution; showing the Operations, Expenditures, and Condition of the Institution for the Year 1864.

Proceedings of the Bristol Naturalists' Society for Four Months ending April, 1866.

Bulletin Mensuel de la Société Impériale Zoologique d'Acclimatation.

Proceedings of the Chicago Academy of Sciences. Vol. I.

The Transactions of the Academy of Science of St. Louis. Vol. II., No. 2.

Journal de Médecine Mentale.

Canadian Naturalist and Geologist.

American Journal of Mining.

Geological Magazine.

Westminster Review.

Proceedings of the Royal Society.

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" " Royal Geographical Society.

" " Chemical Society.

" " Geological Society.

" " Zoological Society.

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